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A GIS Multi-criteria Evaluation for Identifying Priority Industrial Land in Five Connecticut Cities

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Abstract

Rising land values, environmental regulations, lack of investment, and a declining industrial economy greatly threaten the existence of industrial land. Therefore, the purpose of this project is to establish where priority industrial districts are located within five Connecticut cities through the implementation of a GIS weighted multi-criteria evaluation. This tool applies various constraints and factors critical to industrial location and business investment. In addition to identifying suitable industrial districts, a tax base analysis assesses the overall value of industrial land within each community and an employment outlook measures future job growth for Connecticut Workforce Investment Areas. The overall goal of this research is to understand why industrial activity is beneficial within urban areas, what factors contribute to industrial development, and to advocate for the protection of industrial districts for future industrial activity.

Keywords: GIS Multi-criteria evaluation, Industrial Land, Protection, Economic Development, Industrial Development, Industrial Location

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Chapter 1. Introduction

The purpose of this project is to conduct a Geographic Information System (GIS) multi-criteria evaluation (MCE) that identifies and prioritizes industrial districts for future investment, development, and protection. After converting industrial land to commercial, residential, or agricultural parcels, it is nearly impossible to reclaim it, making industrial land vulnerable to disinvestment and displacement (Hoelzel and Leigh 2013). A comprehensive evaluation of industrial land provides context for local and regional officials who are exploring opportunities for job creation and economic development. Prioritizing these districts for future investment improves the site selection process, streamlines construction, and more effectively targets public funding.

Industrial activity is essential to the urban framework; food distributors, warehousing, research and development, recycling facilities, and manufacturing centers provide services and create goods for cities and surrounding areas. In order to provide goods and services to local communities, local businesses acquire outside resources, and utilize them to create finished products eventually sold to the end user. This process boosts the economic base and creates high wage employment opportunities for lower-skilled workers, strengthening a community socially and economically. Active industrial land also diversifies a city's tax base, generating fiscal revenue for community needs and public services. However, blighted industrial property consequently drives down surrounding property values, reducing tax revenue even more. As a result, once thriving industrial cities struggle to rejuvenate these underutilized spaces.

Policymakers and planners realize distressed downtowns and cities require revitalization to foster vibrant, active, and walkable communities. In order to do so, planning goals often consist of implementing smart growth and mixed use development strategies with the intention to create attractive residential and commercial environments. Although these planning techniques are advantageous, they fail to acknowledge the benefits of industrial development. As a result, economic development strategies may overlook industrial activity as practical approach for job creation and business retention.

In addition to strategies that neglect the benefits of industrial activity, abandoned and underutilized industrial space, as well as struggling industrial firms, are at risk of displacement due to real estate market pressure, environmental regulations, and zoning policies. New, appealing commercial and residential uses, developed adjacent to industrial districts, increase the value of land and encourage conversion of the highest and best use from industry to commercial or residential activity. As a result, industrial property owners and firms exposed to rising land values relocate to suburban communities where tax rates or property costs are less.

Figure 1. Abandoned Factories, Bridgeport, CT [1]

[1] http://www.archdaily.com/57093/help-save-remington-arms-factory/

Moreover, unappealing characteristics further confine industrial location, which often defines it as a locally unwanted land use (LULU). For example, recycling centers, heavy manufacturing, or transportation facilities produce pollution, noise, smell, and traffic. In order to regulate location and activity, zoning and environmental policies require specific setbacks to mitigate public nuisances and environmental hazards. Nonetheless, industrial districts allow specific activities required for a fully functioning city.

Project Overview and Research Questions

This project examines land suitability for industrial development, within five Connecticut cities with populations greater than 100,000 residents (Table. 1), based on various land attributes and infrastructure amenities. A GIS-based weighted multi-criteria evaluation measures suitability of industrial districts using by assessing site-specific constraints and factors. These variables, defined by a review of literature on industrial development and best management practices, are essential to the identification of priority industrial districts, which intends to improve the decision making process for industrial developers, policymakers, and planners.

Supplementary to a GIS analysis, employment projections and a brief overview of each city's tax base assesses the economic outlook for Connecticut manufacturing and city property values. Connecticut Workforce Investment Area (WIA) occupational data summarizes business and employment trends from the past decade, and calculates employment forecasts through 2020. The tax base analysis, on the other hand, quantifies the current value of industrial land in each city. These indicators detect the current change in Connecticut manufacturing employment and the growing pressure for cities to depend on non-industrial uses to support fiscal budgets.

Goals

The objective of this project is to answer the following questions:

1. What site-specific criteria should be evaluated when identifying suitable industrial land?
2. Where are industrial tracts located
3. Which sites are priority areas in each major Connecticut City?

In order to protect industrial land, the reader must first understand why it is worth preserving. The rationale for the study discusses the importance and benefits of industrial activity within the urban environment. Second, the project defines specific factors and constraints critical to industrial development. The GIS model applies these variables, which addresses the third question, where are the priority industrial tracts located within each city.

Table 1. Study Area and 2012 Population

City	Population
Bridgeport, Connecticut	146,425
New Haven, Connecticut	130,741
Stamford, Connecticut	125,109
Hartford, Connecticut	124,893
Waterbury, Connecticut	109,915

Source: U.S. Census Bureau, Population Division, Release Date: May 2013, 2012 Annual Estimates of the Resident Population for Incorporated Places Over 50,000

Rationale for the Study

Protecting industrial land is essential to maintaining a diverse and resilient economy, and as a result, requires specific attention. Industrial land not only provides space for development, but it also creates high wage employment opportunities, strengthens and diversifies a city's economy and tax base, and promotes adaptive reuse of existing industrial parcels. In addition, local manufacturing businesses produce goods sold beyond the city, which generates revenue for the local economy with outside money. Appealing industrial

land also gives cities a competitive advantage when attracting new businesses. However, in recent years, the recession has challenged many firms, and all sectors of the economy have struggled, especially manufacturing. Along with a diminishing industrial base, the physical condition of industrial land continues to deteriorate due to a lack of investment, bringing down surrounding property values. Therefore, planners must inventory, prioritize, and protect industrial land in order to strategically practice smart economic and land use development.

Derelict and abandoned buildings strewn throughout the built environment often characterize urban decline. In addition to poor physical development, Connecticut's urban areas, Bridgeport, New Haven, Hartford, Stamford, and Waterbury, are characterized by immense poverty, rampant unemployment statistics, and low high school graduation rates. Each community exceeds the current State unemployment rate (9.2%) and poverty rate (10.0%). The unemployed population in these cities ranges from 10.6% (Stamford) to 19.3% (Hartford), as evident in the table presented below. Moreover, the staggering poverty rates of these cities warrants additional attention. In Hartford, 33.9% of residents live abjectly without adequate employment, finances, or healthcare. New Haven, a city defined by the presence of world-class institutions, has 26.9% of residents living in poverty. Finally, 89.0% of Connecticut residents age 25 years or older graduated from high school. However, each city (except Stamford - 86.2%), falls below this threshold and graduates fewer than 80% of their residents older than 25.

Table 2. Unemployment and Poverty Rates

City	Unemployment	Poverty	Educational Attainment (High School Graduates 25 years or older)
Bridgeport	15.8%	23.6%	73.9%
Hartford	19.3%	33.9%	68.6%
New Haven	13.8%	26.9%	80.5%
Stamford	10.6%	10.8%	86.2%
Waterbury	13.0%	21.9%	78.8%

Source: United States Census, American Community Survey, 2008-2012 5 year estimates

Government Initiatives and Industrial Trends

Government support, initiatives, and market trends predict growth in the industrial sector. As a result, cities should proactively inventory suitable land for investment. President Obama's administration plans to double exports within five years through the Advanced Manufacturing Partnership (Leigh and Hoelzel 2012, 89). Additionally, this growth supports an increasing demand for prime industrial space according to industrial real estate studies (Morris 2014).

Current initiatives and depicted trends verify that the United States industrial economy is growing. The manufacturing sector has added 250,000 jobs since its low point in December 2009, and the U.S. remains one of the largest manufacturing economies in the world. In 2010, 21% of the world's goods manufactured in the States increased its Gross Domestic Product (GDP) value from 11.7% to 21.3% over the last decade (Leigh and Hoelzel 2012, 88). More importantly, urban areas continue to export the majority of U.S. Goods. The 100 largest metro areas produced almost 65% of U.S. export sales and 63% of manufacturing export sales (Istrate and Marchino 2012).

The Connecticut manufacturing sector is also showing signs of improvement. In 2011, total employment stabilized at approximately 165,000 jobs, and manufacturing workforce trends illustrate surprising vitality; 8,000 more jobs were available by this time than originally projected. Furthermore, between 1990 and 2007, technology output increased by more than half. Through 2011, Connecticut ranked 10th in GDP growth amongst all other states. Three years ago, manufacturing was responsible for contributing more than a quarter of the State's 2% increase in real output, second to the financial services sector. In the late 1990s, manufacturing accounted for only one-fifth of the State's annual GDP change.

Connecticut manufacturing employee earnings are also on the rise. Since 2000, earnings increased 41%, 7% greater than all other sectors economy-wide. In addition, the average factory worker earns nearly $77,000 annually (Lanza 2013). High wage employment opportunities, and a greater percentage of weekly pay, provides individuals and families with more income and better standards of living. Furthermore, manufacturing jobs and industrial firms generate goods sold beyond the city, bringing revenue and outside money into the community, enhancing the economic environment.

American manufacturers rely on urban areas for appropriate amenities that offer competitiveness and efficiency as the economy advances into the 21st century (Byron and Mistry 2011). Urban industrial concentration provides close proximity to suppliers and customers, a network of skilled labor, and modern infrastructure for high-tech research and development activities, all of which are critical to the production process (Hoelzel and Leigh 2013). Therefore, protecting urban industrial activity facilitates efficient movement of goods between industries and communities, reducing transaction costs, and enhances knowledge spillover within regional industry clusters.

A growth in business and attraction to urban real estate also boosts demand for industrial property. In 2013, the U.S. industrial real estate market experienced its strongest performance since 2005 (Morris 2014). As transportation costs continue to rise, urban centers provide easy access to transit networks (Morris 2014). Importing, exporting and purchasing products largely influence industrial location. Again, cities provide critical amenities (available labor, infrastructure, and a broad market) to businesses pursuing expansion and growth within their sector.

Smart Growth and Real Estate Pressure

Popularity smart growth strategies encourage sustainable land use; however, such policies fail to identify the benefits of urban industrial land. An evaluation of smart growth publications portray urban industry as an obstruction to future investment and sustainability despite its ability to create jobs, attract business, and mitigate industrial sprawl (Bronstein 2009). Likewise, "by not encouraging industrial revitalization in mixed-use, transit oriented, and infill redevelopment projects, smart growth policies overlook a significant economic sector that contributes to diverse, innovative, and more resilient local economies" (Leigh and Hoelzel 2012, 87-89).

Statewide Smart Growth regulations do not exist within Connecticut. However, many communities and regions implement smart growth strategies. For example, the Capital Region Council of Governments (CRCOG), the State's largest regional planning organization, established smart growth guidelines for sustainable design and development for the 30 Metro-Hartford municipalities. Additionally, the State's "Plan of Conservation and Development" and the "Transit-Oriented Development Toolkit for CT" directly outline and advise communities to comply with Smart Growth principles. However, these planning frameworks

omit the importance of industrial development (Connecticut Office of Policy and Management 2013, 4) (Regional Plan Association, 2013).

Communities are eager to adopt new zoning bylaws, favoring mixed land uses rather than industrial activity because commercial and residential development achieves a quicker build-out rate than industrial uses, allowing towns to attain a higher rate of return on investment (Kotval and Mullin 1994, 302). In many communities, abandoned industrial land portrays a lack of investment. Dilapidated industrial property without marketability impedes the redevelopment process. Instead, commercial and residential real estate developers likely "flip" these properties and attract appealing new uses other than traditional industry. As a result, industrial land is subject to further displacement beyond the city core. In addition, homes, restaurants, and stores outbid industrial activity in a competing real estate market due to generally higher property values, driving industry beyond the urban periphery (Fisher et al. 2003, 43). Primarily, if communities identify and prioritize industrial space, they can better protect land for future industrial activity and mitigate the effects from smart growth encroachment and real estate pressure.

City and Social Benefits

Since the 1970s, manufacturing and industry have been moving beyond the urban edge in search for expansion space, lower costs, and fewer regulations (Giloth and Betancur 1988, 285). Over time, spatial patterns of business growth and decentralization of employment made manufacturing and industrial service jobs inaccessible and difficult to find in many areas of metropolitan regions (Weitz and Crawford 2012, 67). As a result, falling property values due to deindustrialization and underutilized space reduced government revenues, affecting their fiscal budget and ability to support public needs. Therefore, attracting new

business to an urban core enhances a city's economy and relieves pressure from the costs of community services (COCS), and ultimately provides a wealth of new opportunity for the local population: revitalized industrial land generates job potential and establishes real property tax revenue through sustained real estate values. Also, expanding the local economic base and creating basic goods within a community transfers wealth into the local economy from outside of the region (Hoelzel and Leigh 2013). Goods produced by local businesses eventually sold to new consumers, generate new income for companies and employees, which enhance quality of life and the neighborhood economy.

Strengthening and diversifying a city's economy and tax base with industrial land is also beneficial in the form of business retention and tax payments. Urban industrial firms provide jobs to city residents and pay taxes for infrastructure upgrades, public safety, or community services. Instead of an employed city population, who often deals with social costs of increased traffic congestion and pollution, or supporting public projects subsidized by residential tax revenue, local industrial businesses can help alleviate these expenditures through supplementary tax payments (McCarthy 2002, 293). Therefore, it is critical for cities to maintain their economic base and limit business sprawl into suburban communities where land is less expensive. Diversifying a community's tax base supports a city's fiscal budget without increasing additional expenditures for education, public resources, and infrastructure maintenance etc.

Investing in urban industry generates revenue without increasing COCS. In the following example, the city of Warm Springs, California conducted a fiscal impact analysis to assess the economic costs and revenues associated with the development of a motor manufacturing company, while taking into account alternatives involving commercial and

residential development. After estimated increased costs due to residential and commercial investment, the scenario focusing solely on manufacturing and industry calculated the highest net revenue, suggesting that industrial development would be the highest and best use (Strategic Economics 2013). The return on investment from industrialization ameliorates many of the aforementioned social costs within communities without increasing residential population and social services.

In a study conducted by the Farmland Information Group, a survey of 83 communities in 2001 determined industry cost significantly less than residential. The median ratio of revenues to expenditures for industrial land demonstrate that $0.29 per dollar of revenue was spent on local community costs, almost three times as less as residential uses (American Farmland Trust 2013, 6). Fewer homes indicate less pressure on school systems, libraries, hospitals, and other public services. Furthermore, promoting the use of industrial property creates a healthy balance of land uses within the urban framework (Squires 2002, 22).

Environmental Benefits

Redeveloping industrial land is not only a driver of economic development, but is also a strategic method for enhancing the surrounding environment. Many industrial parcels in urban areas are suitable for development, yet they remain vacant, unattractive, and underutilized. The presence of old decrepit buildings and brownfields are aesthetically unappealing to future investors and potential residents. This makes adaptive reuse and redevelopment an intimidating process. However, the environmental benefits may outweigh upfront costs. Contaminated brownfields leach pollutants into the soil and nearby wetlands, affecting the surrounding ecosystem and public water resources. Therefore redeveloping

brownfields in an environmentally sensitive way enhances the value of land and increases marketability while mitigating environmental impacts.

Brownfields are "abandoned, idled, or under-utilized industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived contamination" (U.S Environmental Protection Agency 2011). This contamination is unhealthy to the surrounding natural environment if not properly treated. Identifying large brownfields in quality locations "near a busy central district, freeway interchange, waterfront, or major retail or industry facility" allocates resources to parcels with strong possibility for reuse.

Lastly, industrial jobs located within a dense urban population play a major role in enhancing environmental quality and public health. Built environments designed for walkability promote public transit use, physical activity, and decreased reliance on private vehicles. According to Lachapelle et al. (2011, S72), "higher residential density, greater land use mix, and street connectivity provide nearby destinations that are easy to reach." Destinations in close proximity allow people to ride their bike or walk instead of driving. In addition, utilizing mass transit diminishes energy consumption and greenhouse gas emissions. Commuters can further reduce greenhouse gas emissions and pollution by reducing their journey to work time or utilizing public transit (Lachapelle et al. 2011).

Methodology

Literature Review Methodology

An overview of scholarly articles and development guidelines are critical to the GIS analysis. However, before conducting the GIS process, input variables (constraints and factors), derived from planning guidebooks, best management practices, journal articles, and

industrial development reports, define specific features influencing industrial location. These criteria and standards assess priority locations in detail. Since individual projects are unique, and approaches to evaluate criteria differ, the literature review serves as a guide for the GIS model. Different factors and constraints, specific to individual business needs, may require alternative methods to highlight priority land.

Three sections divide the literature review. The first two sections discuss the constraints and factors evaluated in the analysis, while the last segment reviews the GIS methodology utilized to identify priority industrial land. First, constraints are defined as areas of land that the affect whether or not a site is capable of being developed. These criteria are environmentally sensitive and applied to the process in order to minimize the environmental impact from development and industrial activity. The second section identifies factors, which influence industrial location. These variables are essential to location because they provide amenities for industrial activity. Finally, the last section explains how GIS adequately processes the constraints and factors within a weighted overlay analysis.

GIS Analysis and Inventory Methodology

This project uses Environmental Systems Research Institute's (ESRI) ArcMap 10.1 to conduct a weighted overlay analysis by applying spatial parameters and restrictions to locate and measure priority industrial property. Most practical for this project, ESRI's ArcMap is a familiar tool utilized by planners to manage and analyze data, and assess or monitor geographic and spatial elements. Literature and development standards define spatial standards, acquired from the Connecticut Department of Energy and Environmental Protection (CT DEEP) GIS database and city offices. The constraints assessed in are industrial districts, hydrology, wetlands, floodplains, habitat protection areas, natural diversity

areas, and topography. The following factors, assessed by proximity to industrial land, are sewer service areas, fiber-optic networks, major arterials, and public transportation. The model inventories and prioritizes industrial land in a two-part process. First, zoning policies and GIS data identify city districts that allow industrial activity. After selecting these zones, a constraint analysis removes all undevelopable land in each area. The purpose is to eliminate any existing development hurdles, according to environmental regulations and development standards, inhibiting the development process, in order to improve project feasibility.

The second part of the procedure, also conducted in GIS, applies a factor analysis, which incorporates specific variables essential for industry. A factor analysis examines the spatial relationship between developable industrial land and proximity to existing infrastructure amenities (or factors). The closer the distance of industrial land to each factor, the more suitable the location becomes. The weighted overlay analysis then measures suitability for development and ranks locations as either having a high priority or a low priority for protection and investment. This process applies weighted values to each factor, which vary based on specific requirements or business needs.

Finally, after suitability is measured, a more detailed analysis identifies highest priority industrial parcels larger than 10 acres and not adjacent to residential parcels. Large contiguous acres are compatible for future investment; they allow a community to readily absorb industrial growth with the least amount of restrictions. This inventory suggests that the depicted areas on the final map are strategic for industrial revitalization. Communities can efficiently use existing infrastructure to take advantage of investment opportunities for green technology, niche manufacturing, or eco-industrial parks. These spaces are also critical locations, positioned at the crossroads of major arterials, within utility service areas, and in

walking distance to public transportation systems. With respect to industrial land, proximity to residential areas is least desirable. Therefore, the final part of this analysis highlights industrial zones adjacent to commercial and other industrial business.

Table 3. GIS Analysis Data

	CRITERIA	SOURCE
Land Use and Zoning	Zoning Parcel Size	City Assessors Data
Environmental Constraints	Hydrology Wetlands Floodplains Natural Diversity Database Habitat Protection Areas Topography	Connecticut GIS Data
Infrastructure and Energy	Sewer Utilities Fiber-optics	Connecticut GIS Data National Broadband Map
Transportation	Roads Public Transportation	Connecticut GIS Data Connecticut Transit

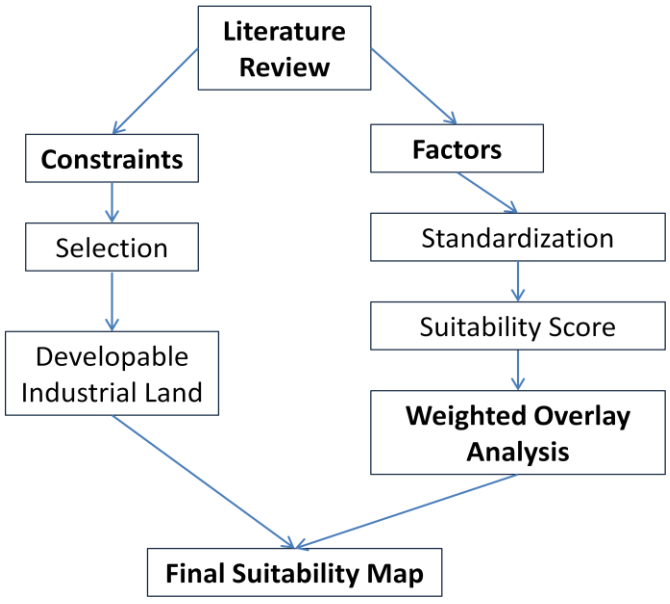

Figure 2. Analysis Overview

Tax Base and Job Projection Analysis Methodology

The State of Connecticut Department of Labor generates industry employment forecasts, using historical trends and population analyses, to measure the change in employment between 2010 and 2010. The calculations depict job growth and decline for various industries within Workforce Investment Areas. More specifically, this section evaluates the manufacturing job base and discusses the future for manufacturing in Connecticut. According to the United States Census, the manufacturing sector is defined as "establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction" (United States Census Bureau, 2012). Job predictions demonstrate required industrial space for future economic and employment growth.

City tax bases are analyzed using land assessment valuations from the State of Connecticut Office of Policy and Management. The summary compares each city's real property tax revenue from 1995 to 2010 for all land use categories. The purpose is to highlight the existing revenue flows for industrial, commercial, and residential tax bases. Moreover, highlighting these trends indicate each community's over reliance on non-industrial uses to sustain their tax base.

Chapter 2. Literature Review

Industrial Land

Industry is described as "Those fields of economic activity including forestry, fishing, hunting, and trapping; mining; construction; manufacturing; transportation; communication; electric, gas, and sanitary services; and whole sale trade" (Moskowitz and Lindbloom 1993). A GIS-based approach is a method to model and analyze land with the least amount of impediments to development. The physical location required for said uses must be suitable for the storage of materials and capital, parking of vehicles and trucks, and internal vehicular circulation (Smith 1981, 32). Appropriately evaluating physical factors and constraints allows cities to tactically attract developers with minimum complication (Jun 2000, 7). The decision process identifies optimal sites while taking into account economic benefits and environmental sustainability. Essentially, the site selection process becomes increasingly valuable where potential facilities may disrupt environmental conditions or public space (Reisi et al. 2011).

Table 4. Physical Factors and Constraints

Constraints (Nominal)	Factors (Ordinal)
Industrial Zoning	Distance to Highways
Hydrology and Wetland Zones	Sewer Service Areas
100-Year FEMA Floodplains	Fiber Optics
Habitat Protection Areas	Surrounding Uses
Topography	Distance to Public Transit
Natural Diversity Database	Distance to Airports

Allocating land and designating industrial zones, according to zoning policies and community values, encourage industrialization (new development) and reindustrialization (the revitalization of existing industrial sites) (Mullin and Kotval 2006, 21). However, communities perceive industrial activity as a threat if zoning bylaws or comprehensive plans

fail to address or promote industrial development. Therefore, industrial firms may find it difficult to locate within a neighborhood whose policies resist future industrialization despite industry's economic and social benefits.

Historically, noxious uses and environmental degradation label industrial activity as a locally unwanted land use (LULU). Therefore, favorable policy promoting industrial revitalization embraces new development with little interference. City master plans that address the benefit of industrial activity suggests to developers that these uses are accepted and recognized as valuable counterparts within the urban framework (Mullin and Kotval 2000). Exclusively zoned industrial land is preferred, especially where large contiguous parcels are adjacent to similar land uses. Abutting parcels buffer and mitigate encroachment, nuisance complaints, traffic congestion, and rezoning requests (Urban Land Institute 1975, 15). Therefore, appropriate zoning standards streamline development and reduce barriers to implementation.

Constraints

Environmental

Land hosting industrial activity presents a variety of environmental issues. Large parking lots, rooftops, and roads, generate impervious surfaces comprising more than 70% of many parcels (Schueler and Holland 2000, 1). This development disrupts the physical environment and hydrological process, resulting in impaired water resources, wetlands, waterways, erosion, and flooding. Proper development and siting can mitigate these effects through environmental impact assessments and planning. Property owners are required to abide by various environmental policies and regulations that promote environmental protection. In addition to ecological sensitivity, the general site must respect surrounding land

constraints. Delineated Federal Emergency Management Agency (FEMA) floodplains and steep slopes confine space for development and prohibit activity or expansion. Preserving and enhancing the natural habitat is vital to the industrial process. Therefore, areas containing the least amount of environmental constraints are preferred (Mullin and Kotval 2006, 20).

Land subject to flooding presents a risk to development and public safety. Traditionally, industrial land is located along rivers and canals because of its proximity to inexpensive hydropower (Urban Land Institute 1975, 12). Adversely, this land remains underutilized because it lies within or adjacent to floodplains indicated by 100-year flood zones, which have a one percent chance of flooding in any given year (Federally Emergency Management Agency). Sites overlapping or adjacent to these areas pose greater insurance costs and risk potential flooding, requiring expensive flood mitigation strategies like barriers and retaining walls. Therefore, development within flood zones is an unattractive characteristic and considered an industrial location constraint.

The goal of the Connecticut Wetlands and Watercourses Act is to minimize the environmental impact from unregulated development, construction, dredging, dumping, and filling of Connecticut waterbodies (Connecticut Regulatory Statutes, Section 22 of Chapter 440). Strategic policy to protect wetlands and waterways for wildlife, groundwater infiltration, and flood control is necessary for a healthy environment (Steiner and Butler 2007, 60). Therefore, a site review and permitting process is required to regulate any new construction if wetlands are present.

Low impact development (LID), a technique utilized to protect wetlands, often increases costs associated with developing wetland protection strategies. Thus, development furthest from these areas is ideal. In a study completed by Reisi et al. (2011), rivers and

waterways buffered by a 1,000-meter (3,280 feet) distance detect undevelopable industrial land due to concerns of environmental degradation. Districts, intersecting these boundaries, restrict or make future development difficult (Ohri et al. 2010, 107). Consequently, the amount of available developable land decreases when wetlands are present. Therefore, wetlands and watercourses are constraints due to potential environmental impacts requiring strict regulations and permitting processes.

Human activity and new construction intensifies wetland, forest, coastal habitat, river, lake, and wildlife habitat degradation. These impacts hinder species richness and biodiversity by separating landmasses and isolating ecosystems. Habitat fragmentation makes it difficult for species to adapt, migrate, or survive in their natural environment (National Wildlife Federation). Water, air, soil, and forest cover also suffer from new construction. As a result, newly proposed projects and planning techniques must consider protecting and enhancing the surrounding environment. The purpose of the Connecticut Comprehensive Wildlife Conservation Strategy is to identify endangered natural communities requiring conservation and protection. Some target areas in Connecticut include acidic white cedar swamps, sand barren landscapes, and poor fen wetlands. Industrial parcels overlapping these habitat target areas restrict development and are impediments to new investment. Therefore, the furthest location from priority habitat areas is most suitable.

Topography and site characteristics affect development, new construction, and environmental quality. Steep slopes in particular and varying topographic gradients are prone to erosion, which ultimately affect storm water runoff and infiltration, sedimentation, and water quality. In addition, precipitous inclines affect site access and development feasibility (Ohri et al. 2010, 108). According to Reisi et. Al (2011), slopes greater than 10 percent are

considered unsuitable for allocating industries. New construction and site improvements may require excavation or the movement of earth for new buildings, parking lots, and access points. Sites identified with greater topographic constraints require approval processes or special permits, increasing the cost and time for a new project to commence. In addition, property owners may be required to implement precautionary measures to mitigate environmental impacts. Thus, level land poses fewer costs and obstacles to development than parcels with more varied terrain.

Factors

Infrastructure and Utilities

Industrial activities rely on available utilities and infrastructure. Wastewater management for manufacturing processes and day-to-day living standards, storm water infrastructure for precipitation runoff, and clean water for daily usage and fire protection is standard for success and the ability to locate within a larger community (Steiner and Butler 2007, 244). In addition, fiber-optic networks improve business connectivity, and natural gas infrastructure improves energy efficiency. However, costs accumulate when properties require initial infrastructure investment. Therefore, preexisting access improves business operations and reduces initial upfront costs of development.

Industries require potable water and contribute to the daily waste generated within a community. Moreover, they are likely to produce large quantities of effluent from industrial processes, increasing the potential for waste to go untreated, resulting in non-compliance with the rules and regulations defined by the 1972 Federal Clean Water Act, requiring the nation's waters to be "swimmable and fishable."[2] In addition, pertinent storm water infrastructure

[2] United States Clean Water Act

drains onsite pollutants, precipitation, and discharge from land surfaces to catch basins and other receiving infrastructure to manage flooding, erosion and runoff in nearby environments (Randolph 2004)). The availability of sewer and water systems allow developers to locate without high costs of capital investment.

Another factor influencing the location of an industry is the availability of inexpensive and available energy. Projected economic growth, stimulated by the emergence of natural gas as a future source of power, gives businesses an upper hand for completing jobs more efficiently. Businesses that have access to this low-cost service are at an advantage (Jacoby et al. 2011), however the exact location of these utilities in Connecticut is considered sensitive information and are therefore not included in the GIS analysis.

Connection to fiber-optic internet is also critical for any industrial facility that may house tenants in need of reliable high-speed internet access. Fiber-optic cables have the capacity to transmit data at a significantly higher rate of speed than previously used copper wiring. The United States National Broadband Plan defines fiber-optic technology as a network capable of transferring data through transparent glass fibers. In urban areas, census blocks delineate available service areas, which are comprised of individual city blocks bounded by streets (National Broadband Map, 2014). Industrial firms investing within these areas require little or no upfront costs to connect to high-speed internet sources.

Transportation

Industrial land serves manufacturing, warehousing, and distribution centers, which require priority locations necessary for receiving, storing, and distributing goods. The location of these establishments is becoming increasingly important as firms compete to deliver their products efficiently as possible. According to Morris (2014), transportation

alone contributes to nearly 60 percent of all supply chain costs. As a result, accessibility to air and highway networks strongly influences location for warehousing establishments. In addition, manufacturing firms also require close proximity to customers and distributors. These businesses receive raw materials to produce finished products, later delivered to surrounding markets. Ideally, close proximity to transportation networks allow delivery of goods and resources in the least amount of time (Bowen Jr. 2008).

In the United States, the Federal Highway Association (FHWA) classifies roads on a scale from one to five. It is most preferable for industrial businesses to locate as close as possible to Class 1 roads, which are defined by the FHWA as "hard surface highways including Interstate and U.S. numbered highways, primary State routes, and all controlled access highways." Systems designed for high speeds provide travelers with uninterrupted modes of travel, and allow industrial firms within proximity to utilize the system to deliver or receive goods without interruption.

The location of industrial land within a city directly influences a company's ability to connect people with their product. According to the literature, there is significant evidence of expanding warehousing companies along major ground transportation arteries. For example, Interstates 20 and 85 near Atlanta, Georgia have seen abundant growth in distribution centers due to the location of interstate junctions (Quinn, 2005). Efficient transportation routes and proximity to major highways are responsible for connecting warehousing companies to various locations serving other communities. In addition, this connectivity within an urban highway system also creates jobs for city residents. According to the literature from an analysis conducted by Ohri et al. (2010), most suitable industrial space is located within 100

meters (328 feet) to a major highway, while as the location increases between business location and highway access, their suitability decreases as a strategic location.

The flexibility of choice also gives firms the control to pick the least expensive method for receiving or distributing goods (Smith 1981, 69-70). Besides highways, airports are equally important and capable of distributing goods to distant locations in a shorter period of time (Bowen Jr. 2008). According to the Connecticut Statewide Airport System Plan (2006) and the Federal Aviation Administration, Bradley International Airport in Windsor, Connecticut and Stewart International Airport in New Windsor, New York, provide cargo services for businesses in the area. These locations offer industrial firms two options for receiving and delivering goods. Evidently, manufacturing or warehousing in close proximity to airports gives businesses an upper hand.

Public transportation access within one-quarter mile of industrial districts is an attractive quality for both business owners and employees. This convenience allows the local residents to utilize public transit, bike, or walk to work. Furthermore, public transit reduces congestion on nearby roadways. However, this is contingent upon commuters who are willing and able to utilize it. According to research studies, one-quarter mile is the distance most people will walk to a bus stop, especially concerning a workplace (Transportation Research Board 2007, 56). As the distance to a transit stops increases, the likelihood for residents to utilize the system decreases. As a result, businesses, homes, and other locations within this network benefit from increased connectivity.

Weighted Overlay Analysis and Multi-criteria Evaluation

GIS enhances land use, environmental management, and economic development decisions. a weighted overlay sensitivity analysis is an effective method utilized to identify

optimum spatial patterns for future land uses according to multiple criteria (Crosetto et al 2000, 72). Where there is a lack of literature defining specific information, a sensitivity analysis quantifies the importance of individual factors necessary to achieve a given precision in the model output (Malczewski 1999). Two methods evaluate input criteria: Boolean overlay and weighted linear combination. The Boolean overlay method assesses criteria with thresholds for suitability in which logical operators, intersection (AND) and union (OR), are applied to specific amenities, factors, and constraints. The weighted linear combination assesses standardized continuous criteria, which then aggregates other factors using a weighted average. The intersection or output produces a land suitability map with respect to map layers (Jiang and Eastman 2000). This project models both factors (criteria ranked ordinally) and constraints (binary values) to spatially measure the degree of importance for each input, in order to identify priority industrial land.

Chapter 3. Study Area Overview

Bridgeport, Hartford, New Haven, Stamford and Waterbury are the five most populated cities in Connecticut, all with populations over 100,000 people. Three of the five cities (Stamford, Bridgeport, and New Haven) are dispersed along the coastal waters of Long Island Sound, while Waterbury and Hartford are situated further inland.

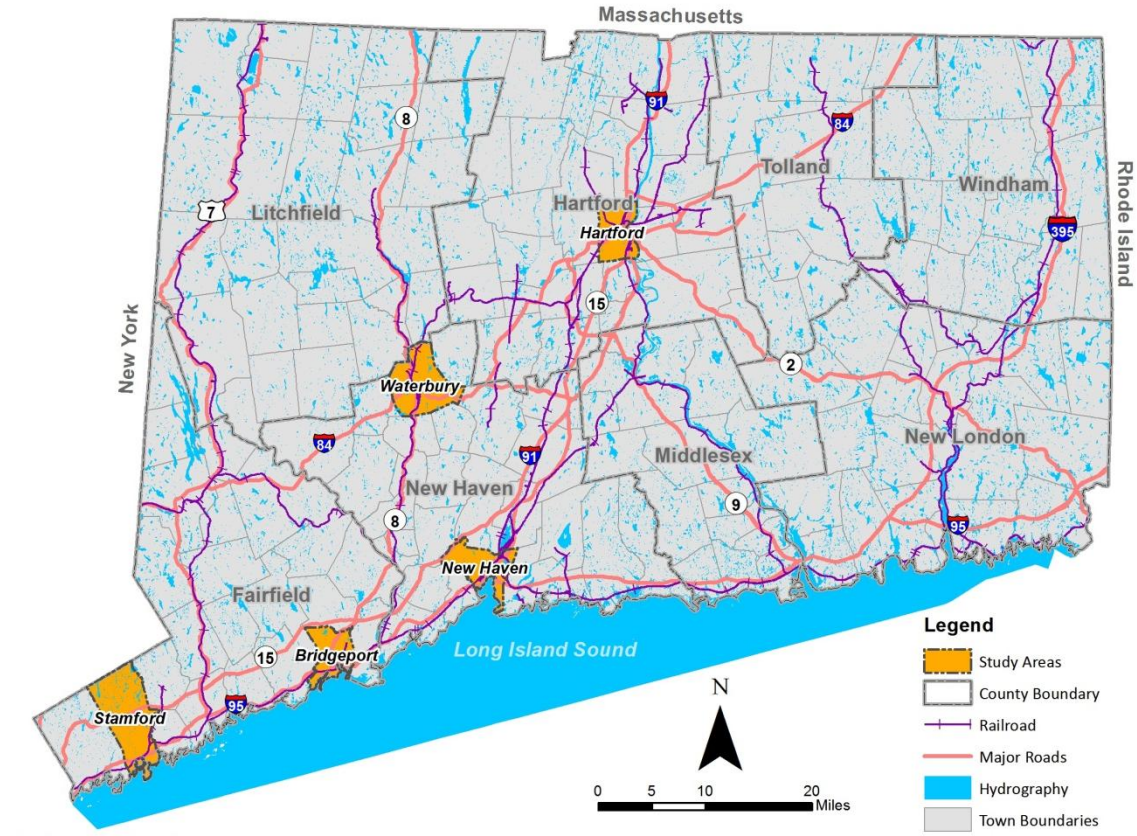

Figure 3. State of Connecticut Study Areas

Table 5. Study Area and 2012 Population

City	Population
Bridgeport	146,425
New Haven	130,741
Stamford	125,109
Hartford	124,893
Waterbury	109,915

Source: U.S. Census Bureau, Population Division, Release Date: May 2013, 2012 Annual Estimates of the Resident Population for Incorporated Places Over 50,000

Bridgeport and Stamford are located in Fairfield County, along Long Island Sound, in the southwest region of Connecticut. Bridgeport, the densest Connecticut city, is home to the most residents and covers just 16 square miles of land. Although it is the smallest community geographically, industrial zones account for nearly 21%, or 2,160 acres of land, more than any other city. Stamford, on the other hand, has the largest landmass, 37.64 square miles, but only delineates only 4% of its property for industry. Alternatively, residential zones account for 90% of city land, and Stamford's prominent central business district is home to four Fortune 500 Companies. Although industry lacks within the city, Stamford generates the largest labor force in Connecticut, most likely due to its location where a large percentage of residents commute daily to New York City.[34]

New Haven and Waterbury are located in New Haven County and are the second and fifth most populated cities in Connecticut. Situated in the south central region of the State, New Haven is at the crossroads of Interstate 95, which connects all of the communities along the coast, and Interstate 91, traverses north and south linking New Haven to Hartford and Springfield, Massachusetts. The location of this community within the highway system

[3] http://stamford.dailyvoice.com/business/11-fairfield-county-companies-make-fortune-500-list, Four Stamford Companies Make The Fortune 500 List 05/06/13
[4] http://www.stamfordct.gov/economic-development/pages/market-profile, market profile

makes it a potentially great location for industrial firms. New Haven is also a major hub for rail transportation, providing service to New York City, Providence, Springfield, and Boston.

Waterbury, also located in New Haven County and geographically positioned further inland to the north, is adjacent to the Naugatuck River and has the second largest landmass amongst the other cities, encompassing 28.52 square miles. Industrial designated zones, however, account for just 10% of the city. The junction of Interstate 84 and State Highway 8 connects Waterbury to Bridgeport in the south and Torrington in the north. Similar to New Haven, Waterbury is also a focal point for rail, connecting passengers to Bridgeport, New Haven, or New York City via Metro North.

Lastly, the northernmost city and state capitol, Hartford, is located along the Connecticut River where Interstates 91 and 84 bypasses through the core of Hartford County. Hartford is the fourth largest community, most well known for insurance and finance industries. Although Hartford has the second smallest land mass, it has the third most industrial space, just behind Waterbury

Table 6. City Land Use According to Assessor's Zoning

City	Total Area (Square Miles)	Industrial (GIS Acres)	% Industrial	Commercial/ Business Land (GIS Acres)	% Commercial/ Business	Residential (GIS-Acres)	% Residential
Bridgeport	15.97	2,160	21%	1,114	10%	7,067	69%
Hartford	17.38	1,763	16%	1,108	10%	4,836	43%
New Haven	18.68	1,762	15%	1,202	10%	7,543	63%
Stamford	37.64	967	4%	1,161	5%	21,591	90%
Waterbury	28.52	1,905	10%	2,586	14%	14,067	77%

Source: United States Census Quick Facts, 2014

Industrial Economic Outlook

Employment, business growth, and salary data indicate how well Connecticut businesses and employees performed between 2002 and 2012 within the manufacturing sector (North American Industry Classification System level 31-33). Although more recent data better represents the current status of manufacturing beyond the recession, information after 2012 is unavailable. Utilizing data from the Connecticut Quarterly Census of Employment and Wages (QCEW) program and Connecticut Department of Labor (DOL), likely changes in occupation growth measure recent trends in manufacturing for cities and Workforce Investment Areas (WIA).

First, an overview of the manufacturing business sector analyzes the change in volume of employees and businesses. Next, DOL Occupational Projections examine employment opportunities for each Connecticut WIA through the year 2020: Southwest WIA (Bridgeport and Stamford), South Central WIA (New Haven), Northwest WIA (Waterbury), and North Central WIA (Hartford). Each WIA is comprised of many towns, representing a regional workforce, as opposed to a specific community. These data assess how technology and growth will continue to affect the industrial make-up and labor pool in each geographic area for the next five to six years.

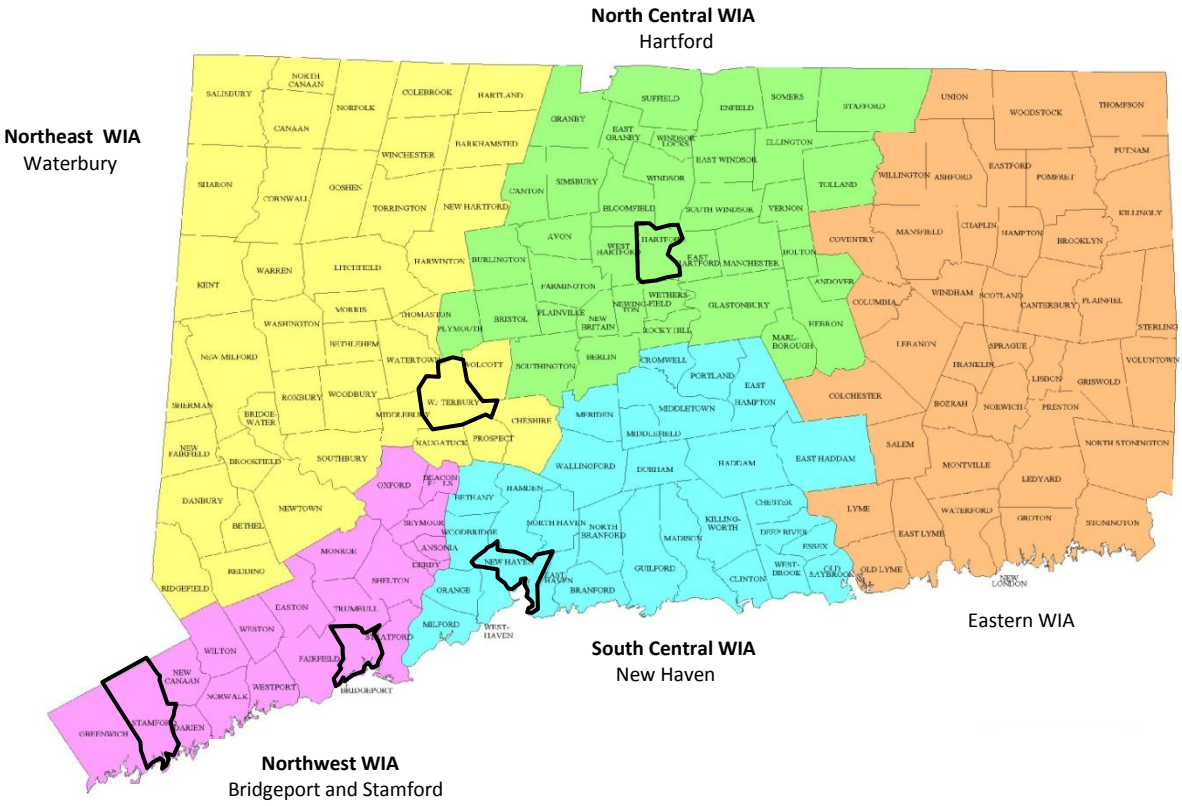

Figure 4. Connecticut Workforce Investment Areas[5]

Between 2002 and 2012, the State of Connecticut lost nearly 46,000 manufacturing jobs, declining from 211,565 employees to roughly 165,000. Even though Connecticut's labor force declined 1.3% during this period, manufacturing's 22% downturn is indicative of firms shrinking, closing, or moving out of Connecticut.

Bridgeport, Stamford, and Waterbury are home to more manufacturing firms and employees than Hartford and New Haven; however, all five cities have consistently lost businesses and jobs. In 2002, Bridgeport was home to 247 companies, which employed 6,492 people. By 2012, these numbers fell drastically to 180 firms (a loss of 67) and 4,131

[5] Source: Connecticut Department of Labor, 20xx, http://www.ctdol.state.ct.us/wia/WIBareas.pdf

employees. Bridgeport alone lost 36.4% of its manufacturing workforce over the ten-year period, more than any other Connecticut city.

Stamford and Waterbury lost a significant portion of their manufacturing base as well, losing approximately 60 factories and 1,800 employees in each city. Moreover, Stamford observed the largest change in total firms. In 2012, nearly 35.7% of existing companies were no longer located in the community. Although Stamford's manufacturing market is declining, the Business and Professional Services, Finance and Insurance, and Information sectors have seen substantial growth over the past ten years. This exchange between job markets illustrates the conversion from goods producing industries to service sector economies, and the potential demise of industrial land by commercial businesses.

Manufacturing business trends are also similar in Hartford and New Haven. Each community, although they are home to the fewest number of manufacturing businesses and employees, experienced the smallest change in rates. In 2002, 101 and 99 manufacturing firms were located in New Haven and Hartford, respectively. By 2012, New Haven lost 10 of these businesses while Hartford, on the other hand, lost nearly three times as many (28.3%). Although Hartford has the third highest rate among all cities, 26% of employees were displaced, the second fewest behind New Haven. New Haven's employment trends were most optimistic: between 2002 and 2012, 18.8% of the manufacturing labor force no longer worked in the city. This number ranges between 7% and 17% fewer than Bridgeport, Hartford, Stamford, or Waterbury.

Most recently, between 2011 and 2012, manufacturing employment in Hartford, New Haven, and Waterbury, and each WIA (except the Southwest) has shown positive signs of growth. Although Connecticut lost only 0.65% of manufacturing laborers between 2011 and

2012, the Southwest WIA lost 1,073 jobs, or approximately 0.65% of their existing employment one year earlier (Figure 5). On the contrary, workers in all other cities and regions were able to find employment within the manufacturing sector despite the tendency for businesses to close. Regardless of the amount of firms closing over this time, the quantity of employees in each community and region remained either stable or increased. Although the changes are minimal, New Haven experiences the most growth, adding 267 manufacturing jobs to the city over the one-year period, a 10.5% increase. In addition, Hartford accumulated 2.8% growth and Waterbury added just eight jobs (Figure 4). As long as thriving companies hire potentially displaced workers, the manufacturing sector may begin showing signs of improving business conditions.

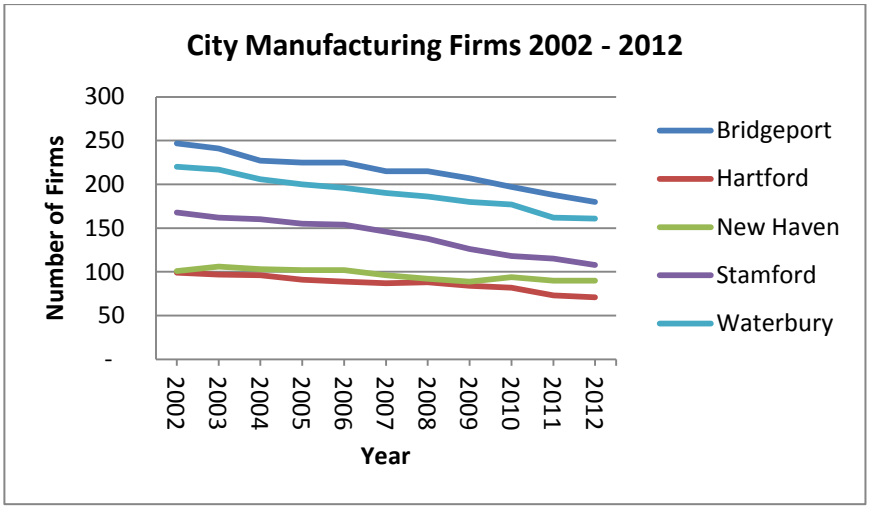

Figure 5. Manufacturing Firms per City from 2002-2012

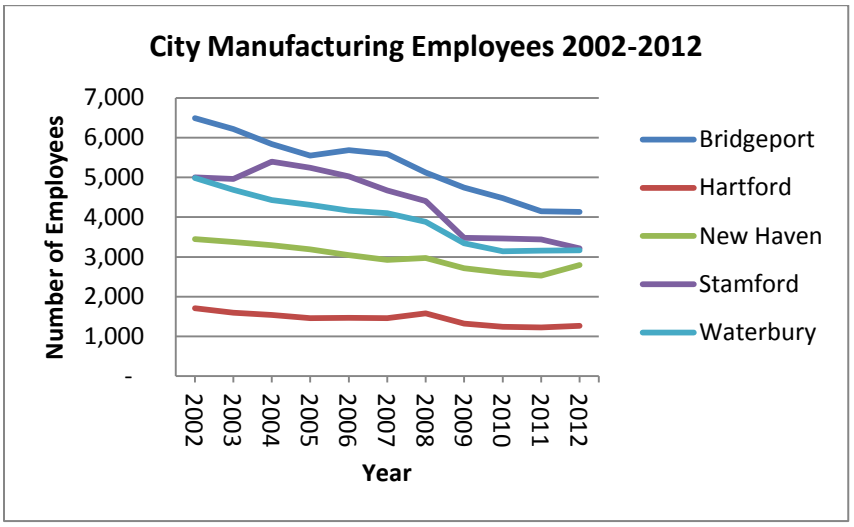

Figure 6. Manufacturing Employees per City from 2002 to 2012

The North Central and South Central WIA's are home to the majority of manufacturing employees even though Hartford and New Haven are located within these districts (Figure 5). As mentioned before, these cities have the smallest manufacturing workforces, signifying that a majority of manufacturing businesses, located within each WIA, are in suburban communities. As a result, both cities most likely rely on other industry sectors for economic stability. For example, finance and insurance industries make Hartford a well-known community, while New Haven is home to excellent educational institutions and hospitals.

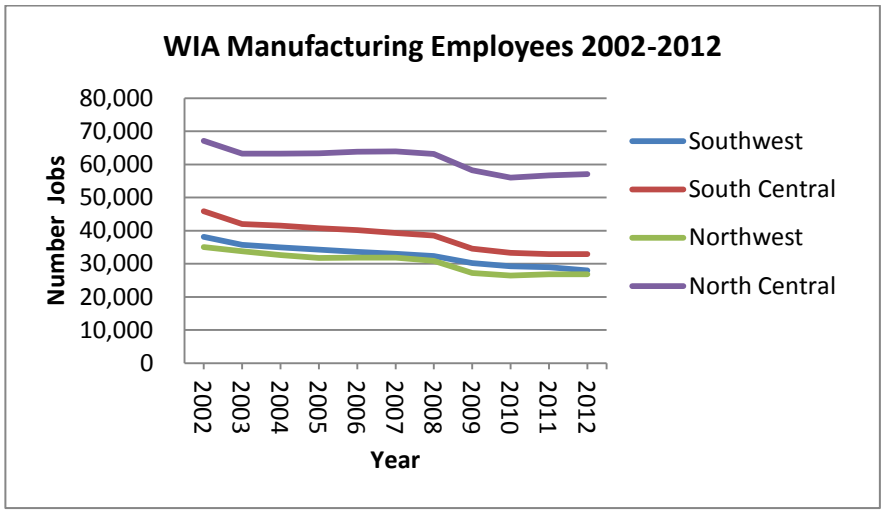

Figure 7. Manufacturing Jobs per WIA from 2002 to 2012

Table 7. Change in Employment and Firms, 2002 to 2012 in Connecticut Cities

Change 2002-2012	Bridgeport		Hartford		New Haven		Stamford		Waterbury	
	#	%	#	%	#	%	#	%	#	%
Firms	-67	-27.1%	-28	-28.3%	-11	-10.9%	-60	-35.7%	-59	-26.8%
Employees	-2,361	-36.4%	-443	-26.0%	-648	-18.8%	-1,788	-35.8%	-1,818	-36.5%

Regardless of this recent upturn in manufacturing employment, the outlook for jobs within this sector predicts a slow decline through the year 2020. The DOL Office of Research utilized historical trends and individual forecasts to create ten-year industry employment projections for each WIA (State of Connecticut Department of Labor).

Between 2002 and 2010, Connecticut lost nearly 46,000 jobs. This staggering decline, however, is expected to slow considerably. The State is projected to lose only 3,890 more manufacturing jobs between 2010 to 2020, and although jobs will still be lost, the anticipated shock will be much less severe than the previous decade's economic collapse. Over the next few years, evidence of a steady job market predicts job displacement to diminish. The South

Central, North Central, and Southwest regions expect a loss of 3.1% to 3.3% of existing jobs. The Northwest, however, anticipates losing just 0.6% of existing manufacturing jobs.

Table 8. Manufacturing Employment Projections - 2010 to 2020

	Employment Estimate 2010	Employment Projection 2020	Employment Change 2002-2010	% Change 2002-2010	Employment Change 2010-2020	% Change 2010-2020
Connecticut	165,565	161,675	-46,000	-21.7%	-3,890	-2.3%
Southwest	29,225	28,323	-8,946	-23.4%	-902	-3.1%
South Central	33,356	32,272	-12,490	-27.2%	-1,084	-3.3%
Northwest	26,525	26,354	-8,523	-24.3%	-171	-0.6%
North Central	56,116	54,307	-11,034	-16.4%	-1,809	-3.2%

Despite these deficits, manufacturing in Connecticut remains one of the highest paying industries, averaging $78,893 per capita annually, the fourth highest behind Professional and Business Services, Information, and Financial sectors. Annual average wages for manufacturing employees in each WIA are also consistently higher than most other industries. In the Northwest and South Central regions, manufacturing employees are the highest wage earners; and in the North Central and Southwest, manufacturing is third and fourth most profitable, respectively (Table 7).

Table 9. Major Industry Sector Annual Average Wage by WIA - 2012

	Connecticut	North Central	Northwest	South Central	Southwest
Total, All Industries	$62,159	$60,181	$51,111	$51,850	$86,926
Construction	$56,548	$58,073	$55,144	$56,853	$59,264
Manufacturing	$78,983	$77,028	$78,796	$70,866	$91,713
Trade, Transp. & Utilities	$46,864	$41,479	$39,102	$40,354	$59,949
Information	$86,955	$88,804	$60,808	$70,577	$105,961
Financial Activities	$142,164	$110,676	$76,491	$68,625	$243,628
Prof. & Business Svcs.	$80,676	$69,345	$72,724	$61,210	$111,700
Educ. & Health Svcs.	$50,030	$49,460	$46,058	$55,206	$51,001
Leisure & Hospitality	$20,280	$17,985	$19,654	$18,715	$24,900
Other Services	$31,028	$32,351	$26,350	$29,834	$33,781
Government	$55,749	$59,028	$52,763	$58,067	$60,623

Tax Base Analysis

A tax base analysis measures how industrial land values have changed between 1995 and 2010, in contrast to residential and commercial uses (See Appendix A).[6] [7] Moreover, data indicate whether communities rely more heavily on non-industrial activity to support their fiscal budget. In addition to evaluating real property tax revenue, the total square footage of industrial districts, according to 2014 zoning, is divided by 2010 real property tax revenue (measured in 2014 dollars), which estimates industrial property values for each city. It is important to note that these estimates measure the difference between most recent zoning (2014) with 2010 tax revenue and does not account for the change in quantity of land within each land use category.

Each city, except Hartford, generates more than 60% of their fiscal revenue from residential land, which has continued to expand over the past 15 years. This rate signifies each community's over reliance on non-industrial activity to support fiscal budgets.

[6] It is important to note that the analysis does not assess the change in quantity of land during this time period.

[7] All values are calculated in 2014 dollars

Moreover, although commercial property has devalued over the years, it remains a critical component of each city's tax base.

Bridgeport and Stamford's industrial property tax revenue grew slightly between 1995 and 2010. By the end of 2010, Bridgeport generated 9.6% revenue from industrial property, gaining 2.0% since 1995. Although this growth is minimal, residential and apartment properties outpaced industrial, increasing from 65.9% in 1995 to 73.4% in 2010.

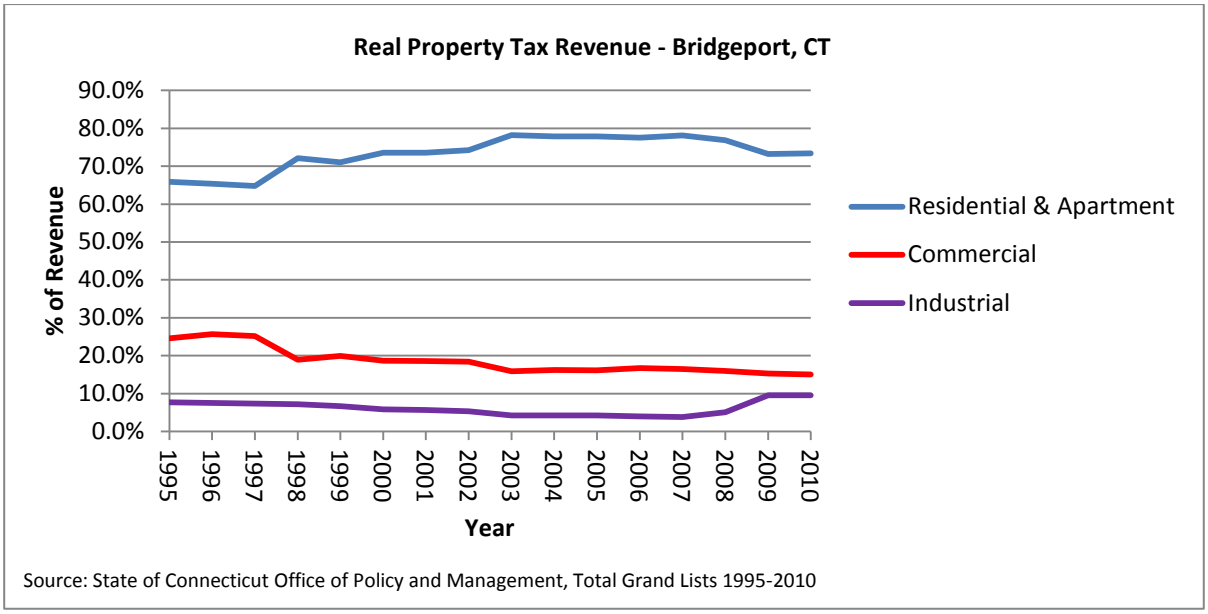

Figure 8. Real Property Tax Base

Similarly, Stamford's industrial tax revenue also fluctuated during the 15 year period, and was worth more in 2010 than in 1995. However, industrial revenue increased just 1.1%, while residential and apartment land revenue grew nearly 4%, contributing 70% to the fiscal budget. Although revenue increased from industrial properties, commercial revenue declined, signifying the possible conversion of land from commercial to residential.

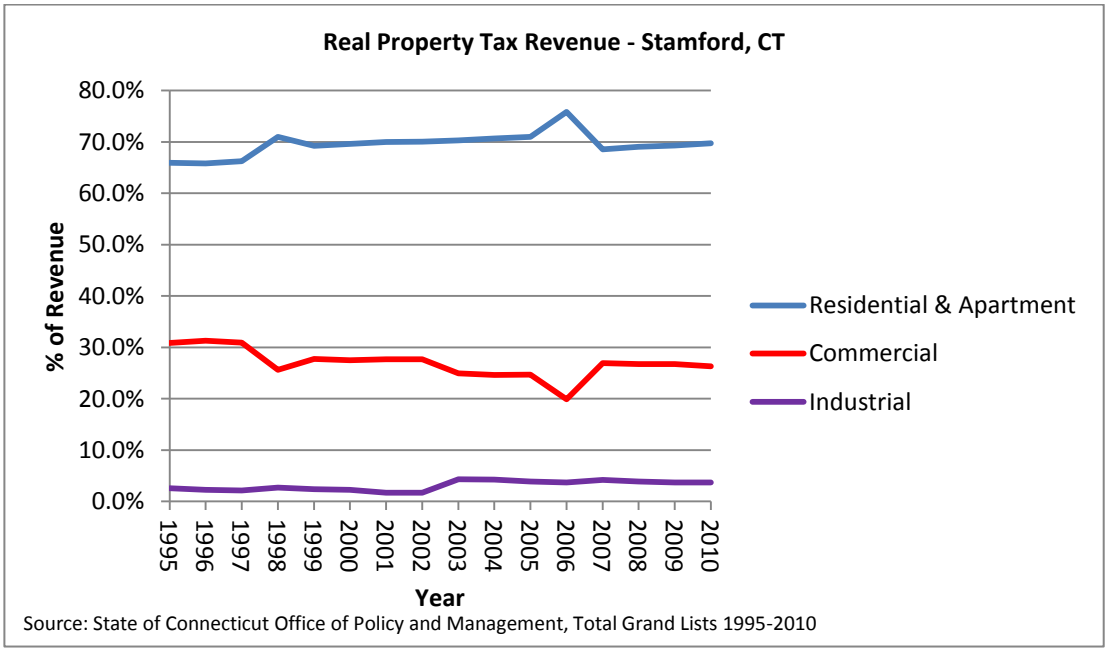

Figure 9. Stamford Real Property Tax Base

Unlike Stamford and Bridgeport's slight growth in industrial revenue, New Haven, Waterbury, and Hartford's industrial properties generated less revenue in 2010 than in 1995. Hartford's industrial value declined 2.7%, while residential and apartment value increased, contributing an additional 10% to the fiscal budget over the years. New Haven's value declined minimally, less than 1%, while residential grew 8.5%. Finally, Waterbury's industrial tax revenue declined 6.6% as residential and apartment uses climbed 13.9%. These data signify each communities growing dependency on residential uses to support their fiscal budgets, and the overall decline of industrial firms and value of industrial properties.

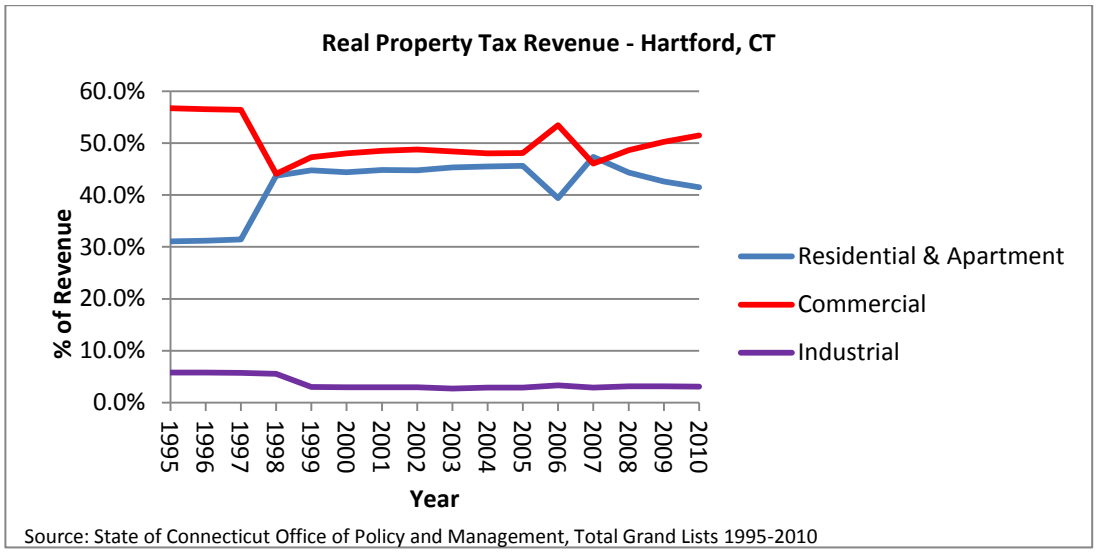

Figure 10. Hartford Real Property Tax Base

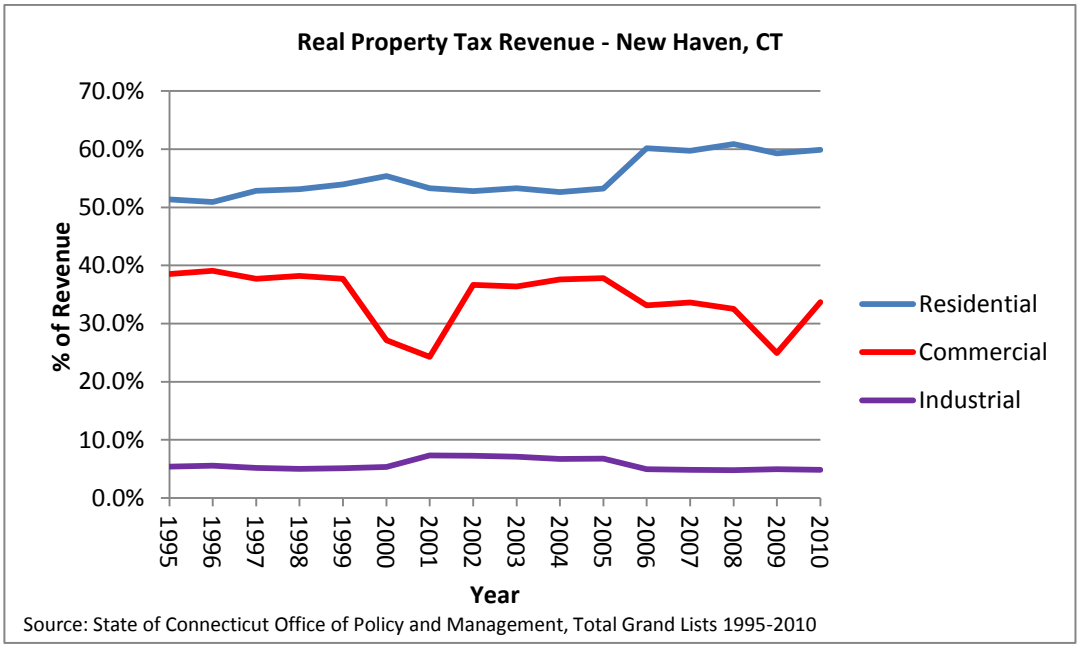

Figure 11. New Haven Real Property Tax Base

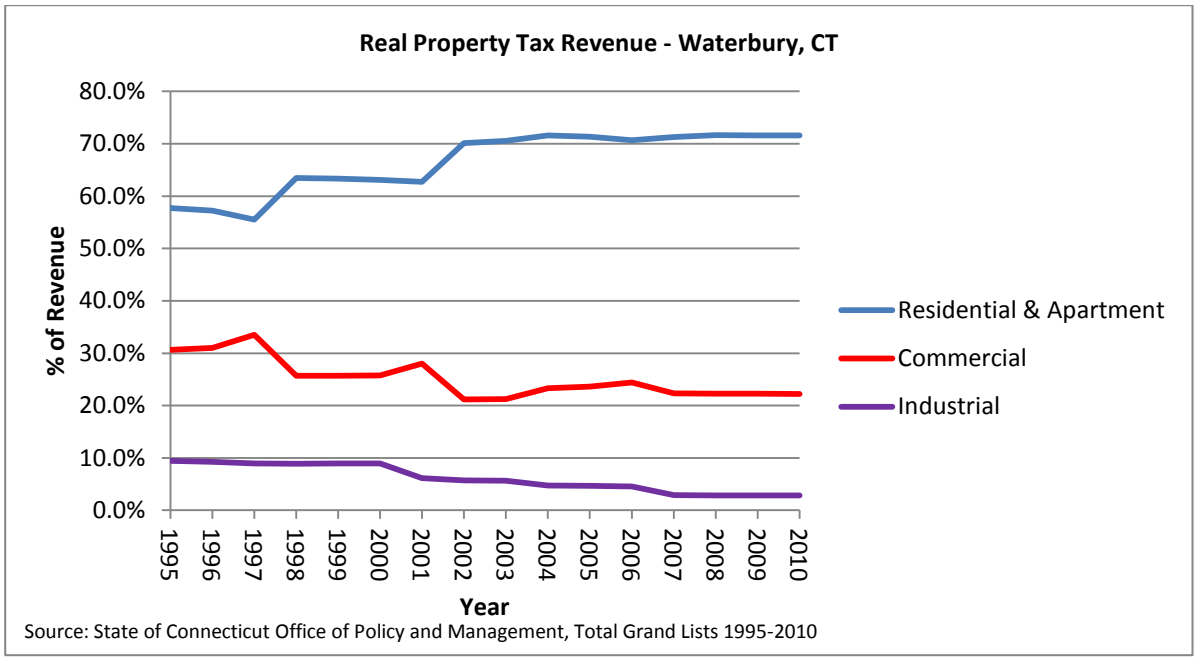

Figure 12. Waterbury Real Property Tax Base

Each city's property tax rate also exceeds the Connecticut average of $19.90 per $1,000 of assessed value. High tax rates often defer property investors because of large yearly costs to own land, especially if it becomes underutilized. Stamford has the lowest tax rate amongst each city, just $24.04, while Bridgeport and Hartford administer approximately $40.00 per $1,000 assessed, Waterbury - $56.78, and Hartford - $74.29. Contrary to high tax rates, industrial property (including land and structure) in each city, except Stamford, is valued very low. Stamford's industrial property is worth $21.35 per square foot, but each city is valued much less: Bridgeport's is worth $6.53 per square foot, New Haven's is worth $4.04 per square foot, and Hartford and Waterbury's industrial properties are worth $1.21 and $1.73 per square foot, respectively. High tax rates and uncompetitive land values make investing in industrial property a difficult endeavor. Large upfront costs for revitalization reduce greater opportunity for a quick return on investment, affecting the financial feasibility of a project and discouraging industrial activity.

Table 10. Mill Rates and Value of Land per Square Foot (2014 Dollars)[8]

	FY2014 Mill Rate (per $1,000 assessed)	Residential & Apartment Value (per SQ FT)	Commercial Value (per SQ FT)	Industrial Value (per SQ FT)
Bridgeport	$41.86	$15.31	$19.93	$6.53
Hartford	$74.29	$6.01	$32.53	$1.21
New Haven	$40.80	$11.74	$41.49	$4.04
Stamford	$24.04	$18.01	$126.26	$21.35
Waterbury	$56.98	$5.92	$10.00	$1.73

[8] Value of 2010 land use according to 2014 Assessor's zoning data

Chapter 4. GIS Analysis

A GIS multi-criteria evaluation identifies industrial land suitable for protection and investment in a three-part analysis. First, Part 1 conducts a constraint analysis to identify and remove any environmental restrictions within industrial zones; all remaining land, defined as developable and assessed through the end of the GIS process, is measured for suitability. After removing all constraints and classifying developable land, Part 2 conducts a weighted overlay factor analysis, measuring four different criteria effecting location and suitability for industrial business investment. Lastly, Part 3 combines developable industrial land from Part 1 with the output from Part 2 to identify the most suitable developable industrial districts. In addition, the analysis identifies industrial parcels not adjacent to residential land uses, and one prime parcel, prime for investment, demonstrates principle industrial location characteristics

Part 1: Constraint Analysis

A constraint analysis identifies areas of land that restrict or make development and investment impractical according to Best Management Practices and development guidelines. Based on literature and reports, industrial zones have six constraints removed from existing districts: hydrology, wetlands, 100-year flood zones, habitat protections areas, natural diversity areas, and slopes greater than 15% (derived from a GIS slope analysis using 1/3 arc-second USGS National Elevation Data). Connecticut's GIS database, organized by the Department of Energy and Environmental protection CT DEEP, provide all other data layers. The analysis merges each environmental constraint into one layer, and after these areas of land are "erased" from the process, developable industrial land remains for each Connecticut city. The final output creates one definitive layer called Developable Industrial Land.

Developable Industrial land is primarily located along the corridors of major highways and rivers traversing through each city, represented in purple on the five maps displayed below. Table 11 above also depicts the amount of industrial land within each city. After removing the constraints from industrial districts, Hartford, Bridgeport, and Waterbury each have over 1,000 acres of developable industrial land. New Haven and Stamford, however, have much less, controlling only 480 and 671 acres, respectively. Due to environmental impacts associated with new development, some cities lose more than half of their industrial zoned land during the constraint analysis, signifying why it is critical to inventory and distinguish prime developable industrial properties.

Table 11. Developable Industrial Land

City	Total Industrial Land (GIS Acres)	Developable Industrial Land (Constraints Removed) (GIS Acres)	Percent Developable Industrial Land (Constraints Removed) (GIS Acres)
Bridgeport	2,160	1,277.12	59.1%
Hartford	1,763	1,281.8	72.7%
New Haven	1,762	479.7	27.2%
Stamford	967	671.4	69.4%
Waterbury	1,905	1,082.0	56.8%

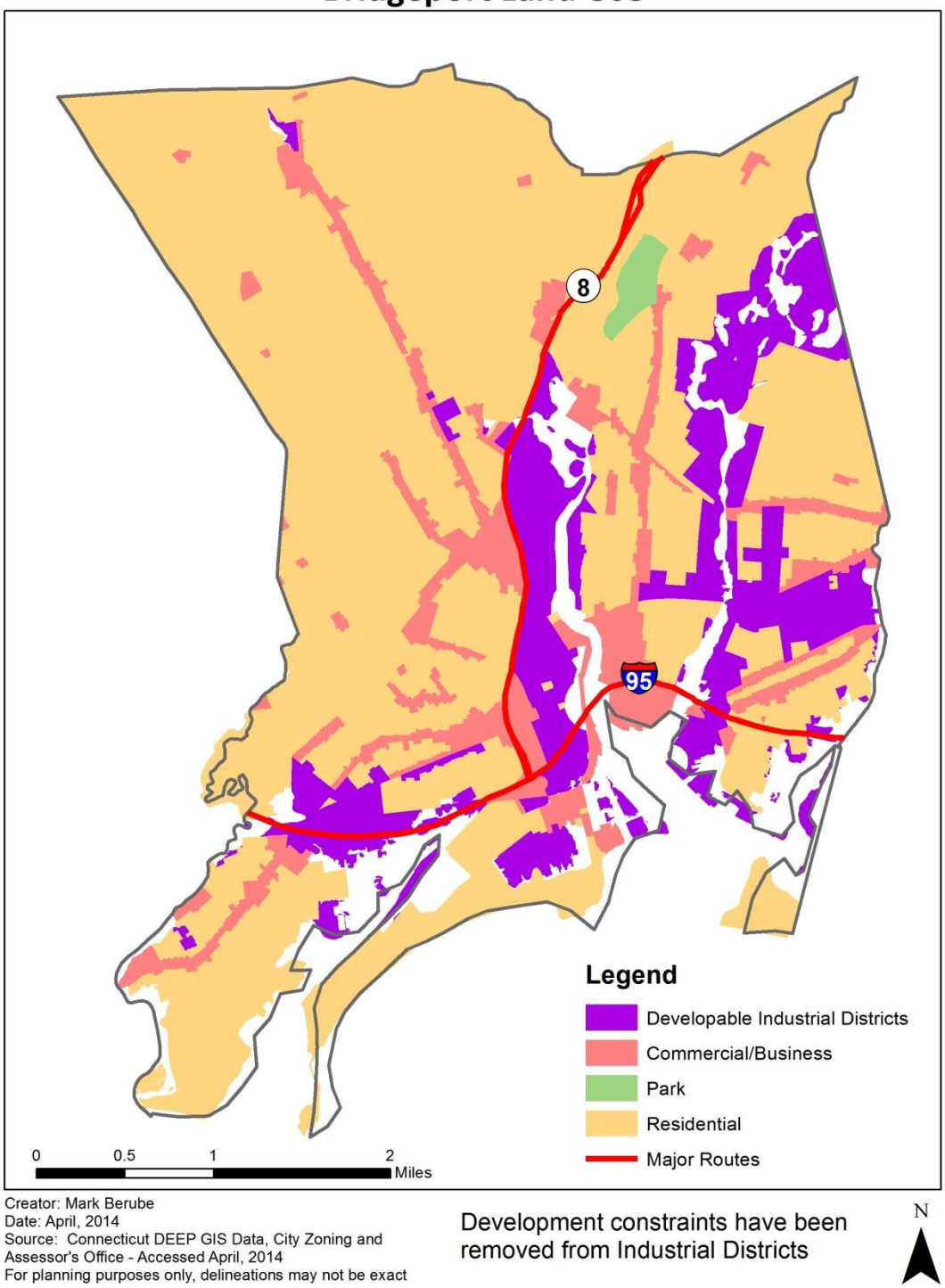

Figure 13. Bridgeport Existing Land Use Depicting Developable Industrial Land

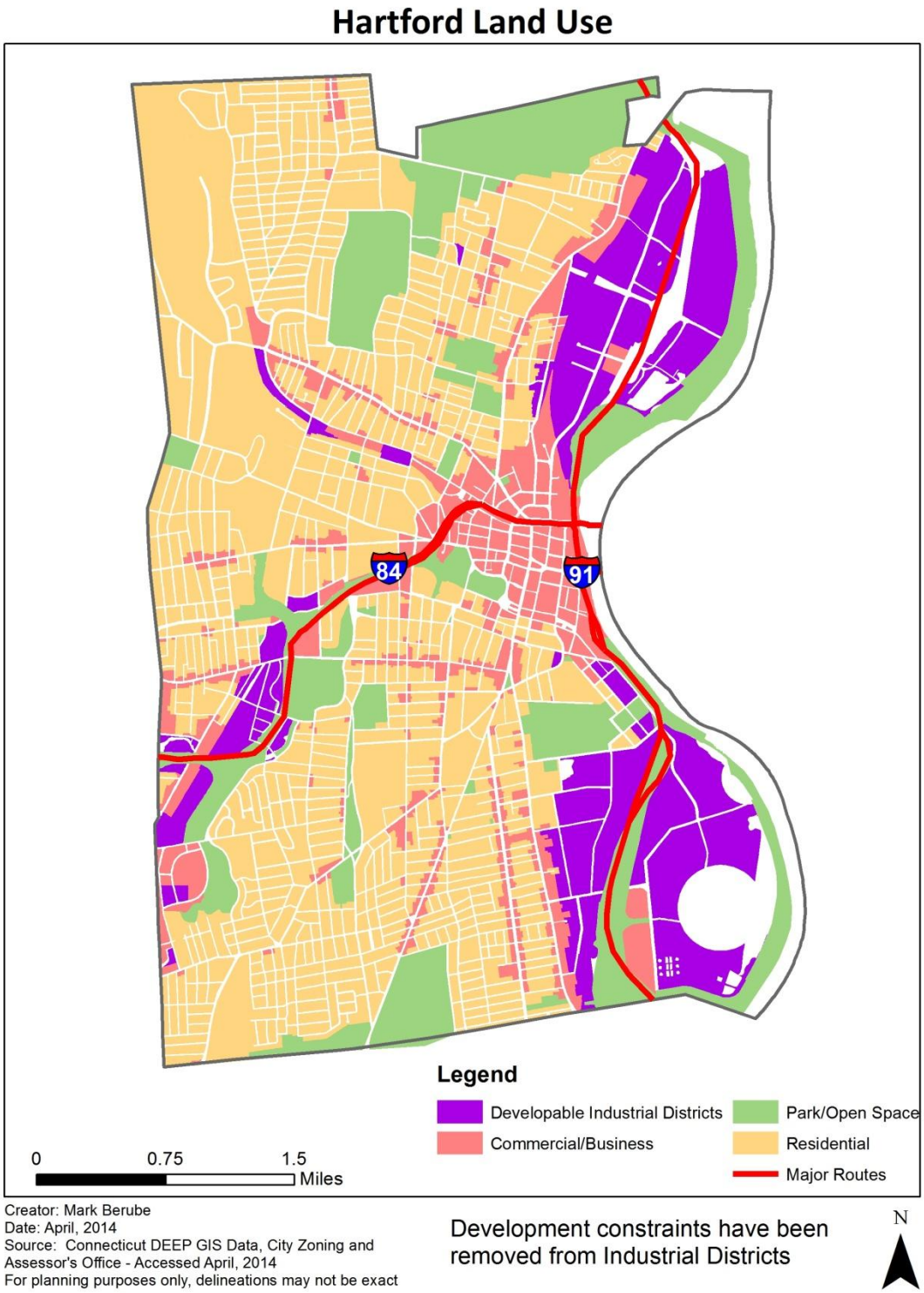

Figure 14. Hartford Existing Land Use Depicting Developable Industrial Land

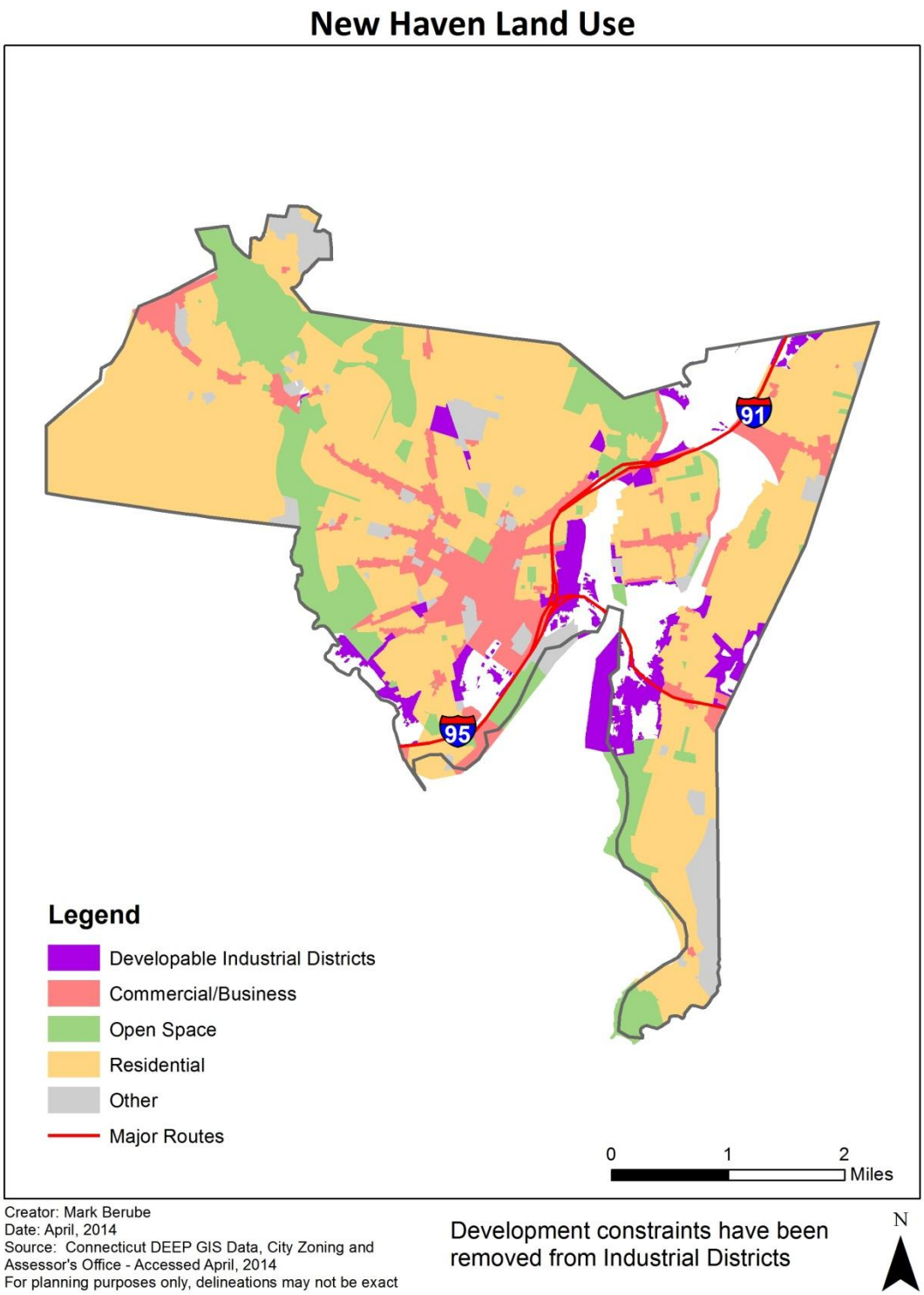

Figure 15. New Haven Existing Land Use Depicting Developable Industrial Land

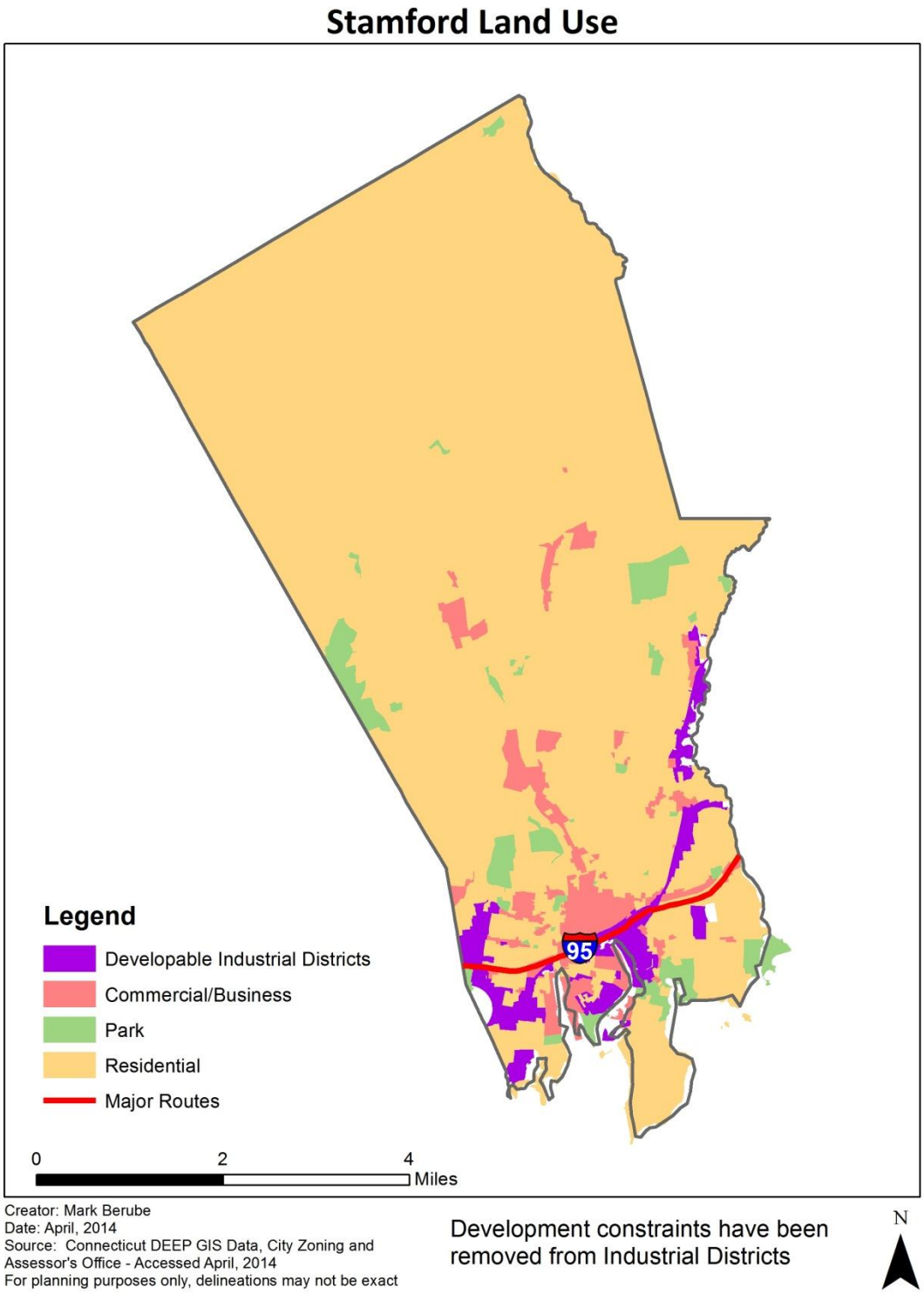

Figure 16. Stamford Existing Land Use Depicting Developable Industrial Land

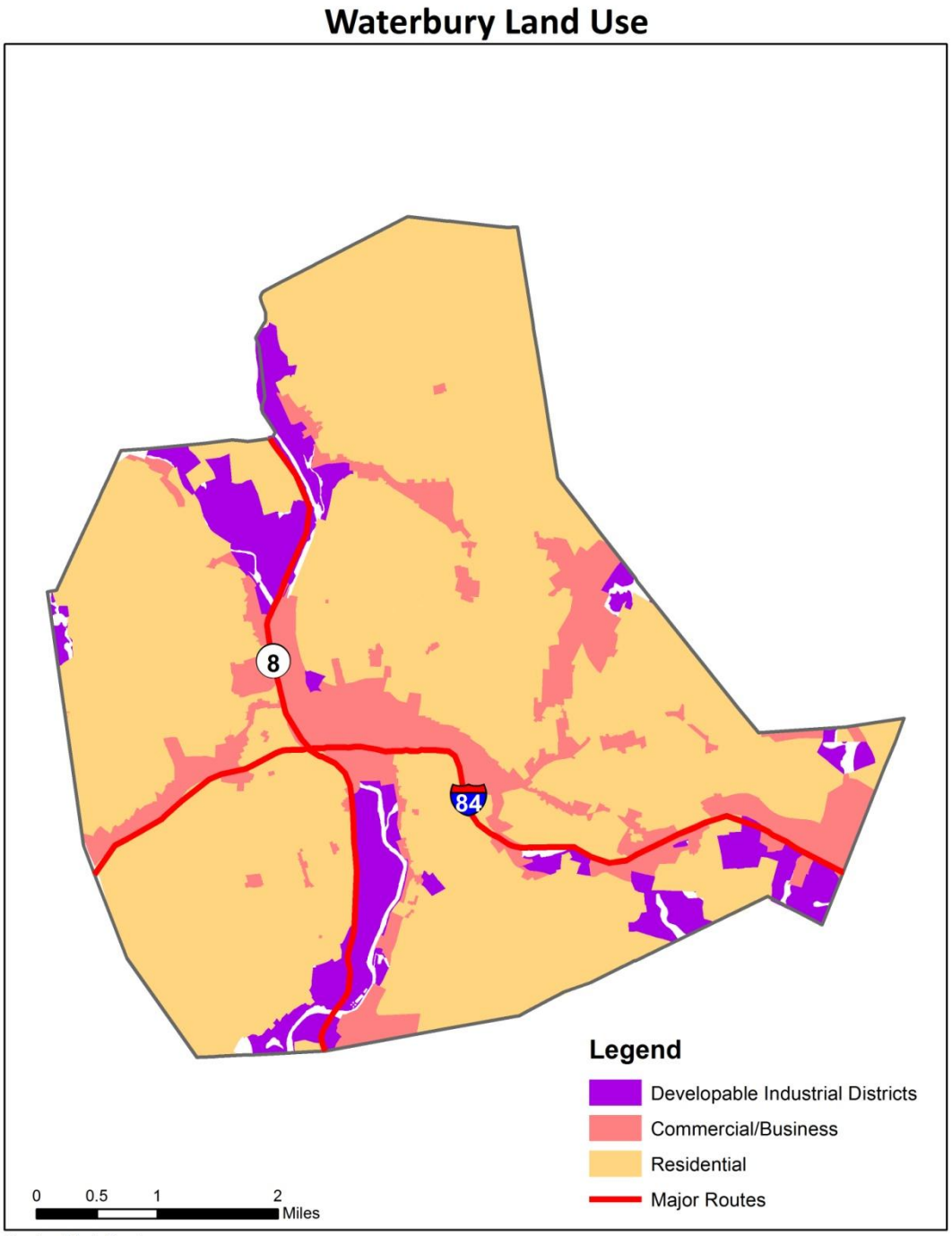

Figure 17. Waterbury Existing Land Use Depicting Developable Industrial Land

Part 2: Factor and Weighted Overlay Sensitivity Analysis

Part 2 of the GIS analysis measures location suitability based on four industrial development amenities: public transit routes, major routes, fiber-optic service areas, and sewer service areas. The analysis categorizes developable industrial land into six suitability classifications: locations identified by the highest value (6) are located within the most suitable zone, while the lowest value (1) designates the least suitable locations, situated furthest from critical amenities. Table 12 specifies these ranges and values in more detail where a weighted percentage ranks each factor.

After each factor is classified and mapped according to the distances listed in Table 12 (displayed in Figures 15 through 19), the weighted overlay tool assigns specific weights (percentages) to emphasize spatial significance of each input criteria; a factor assigned a larger percentage has a more significant impact on the output rather than a factor assigned a smaller percentage. For this analysis, major routes are considered the most important and are given a weight of 40%; fiber optic service areas and sewer service areas are considered second most important and assigned a weight of25%; and lastly, the least critical factor, public transit service areas, are assigned the smallest value of just 10%.

Table 12. Weighted Overlay Factor Criteria

Raster Datasets	Weighted Importance	Assigned Cell Values					
		Most Suitable		→			Least Suitable
		6	5	4	3	2	1
Public Transit (Miles)	10%	0.25	0.5	0.75	1.5	2.0	3.0
Major Routes (Miles)	40%	0.25	0.5	0.75	1.0	2.0	6.0
Fiber-optic Service Areas (Miles)	25%	0.25	0.5	0.75	1.0	2.0	6.0
Sewer Service Areas (Miles)	25%	0.25	0.5	0.75	1.0	2.0	6.0

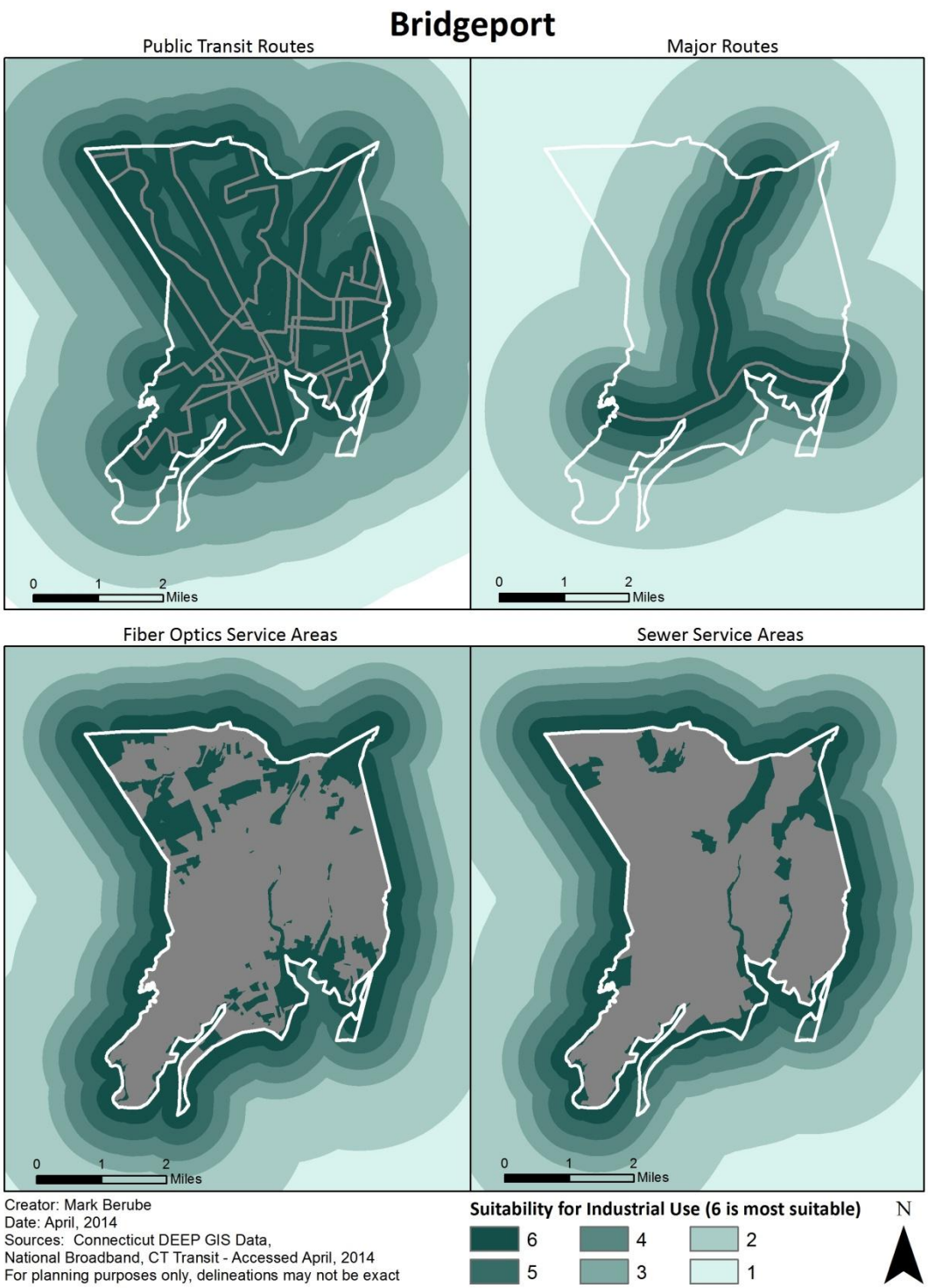

Figure 18. Bridgeport Factors Classified by Suitability

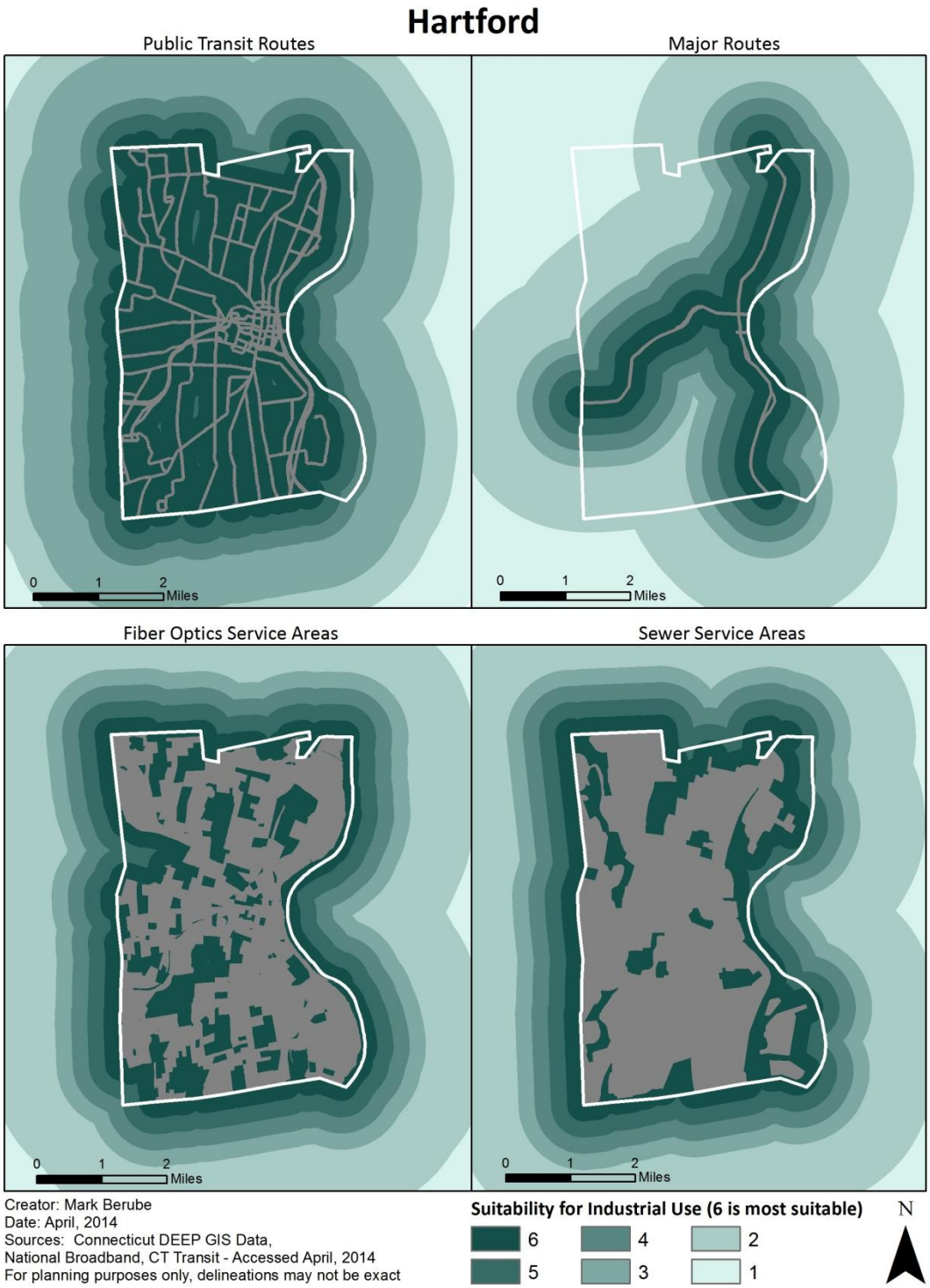

Figure 19. Hartford Factors Classified by Suitability

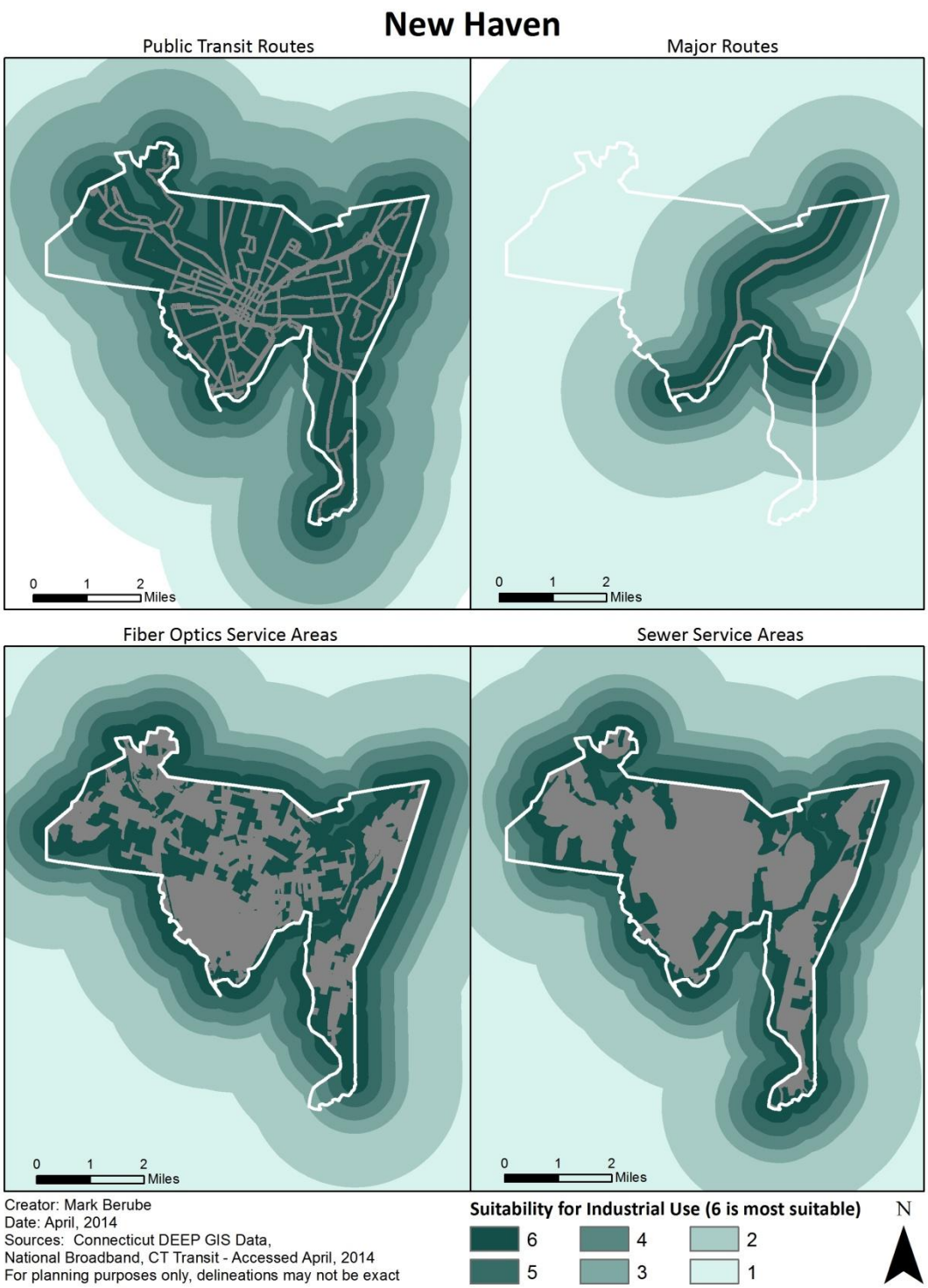

Figure 20. New Haven Factors Classified by Suitability

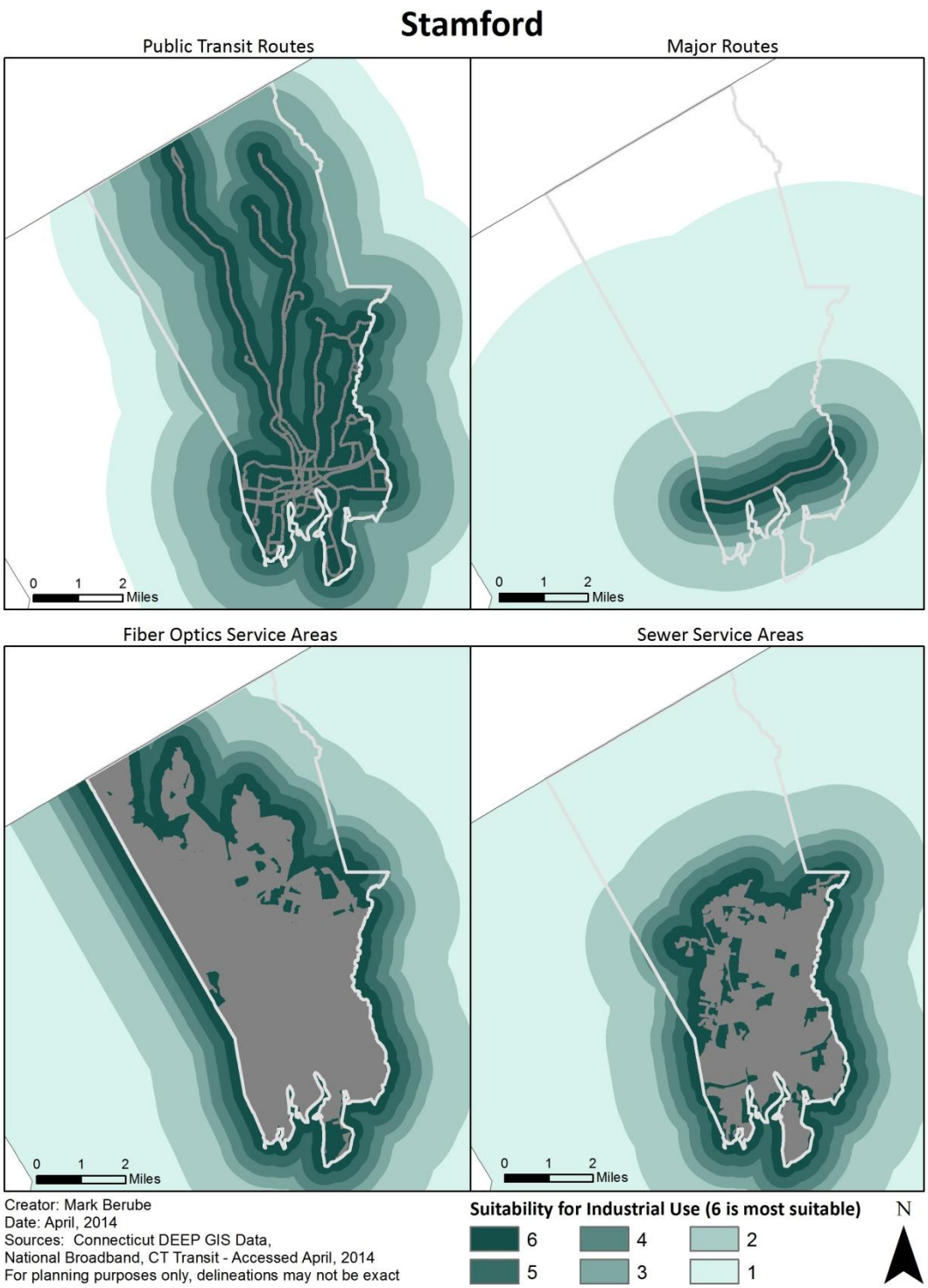

Figure 21. Stamford Factors Classified by Suitability

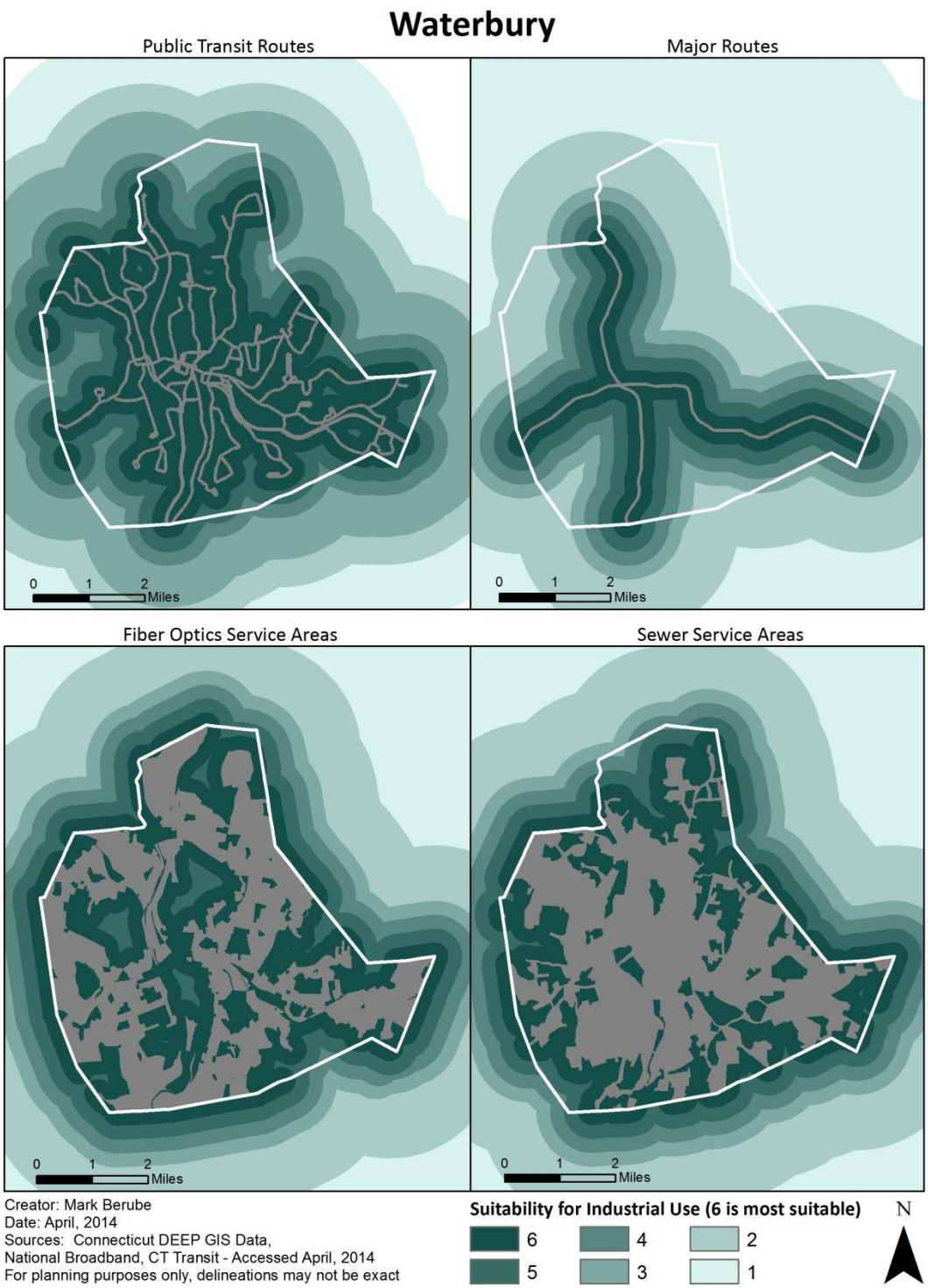

Figure 22. Waterbury Factors Classified by Suitability

Part 3: Final Suitability Analysis

The final suitability analysis applies the raster calculator tool to identify priority industrial locations in each city. Developable industrial land produced in Part 1 is multiplied by the weighted overlay analysis produced in Part 2, and illustrates developable industrial districts by suitability ranking in varying shades of orange, mapped in Figures 20 through 24.

Depicted industrial districts vary in color grades of orange: the darker the shade, the higher the priority for protection or investment. These areas overlap the factor analysis, which also depict suitability, defined by different shades of green. In addition, a purple diagonal pattern depicts industrial parcels not adjacent to residential areas within each city.

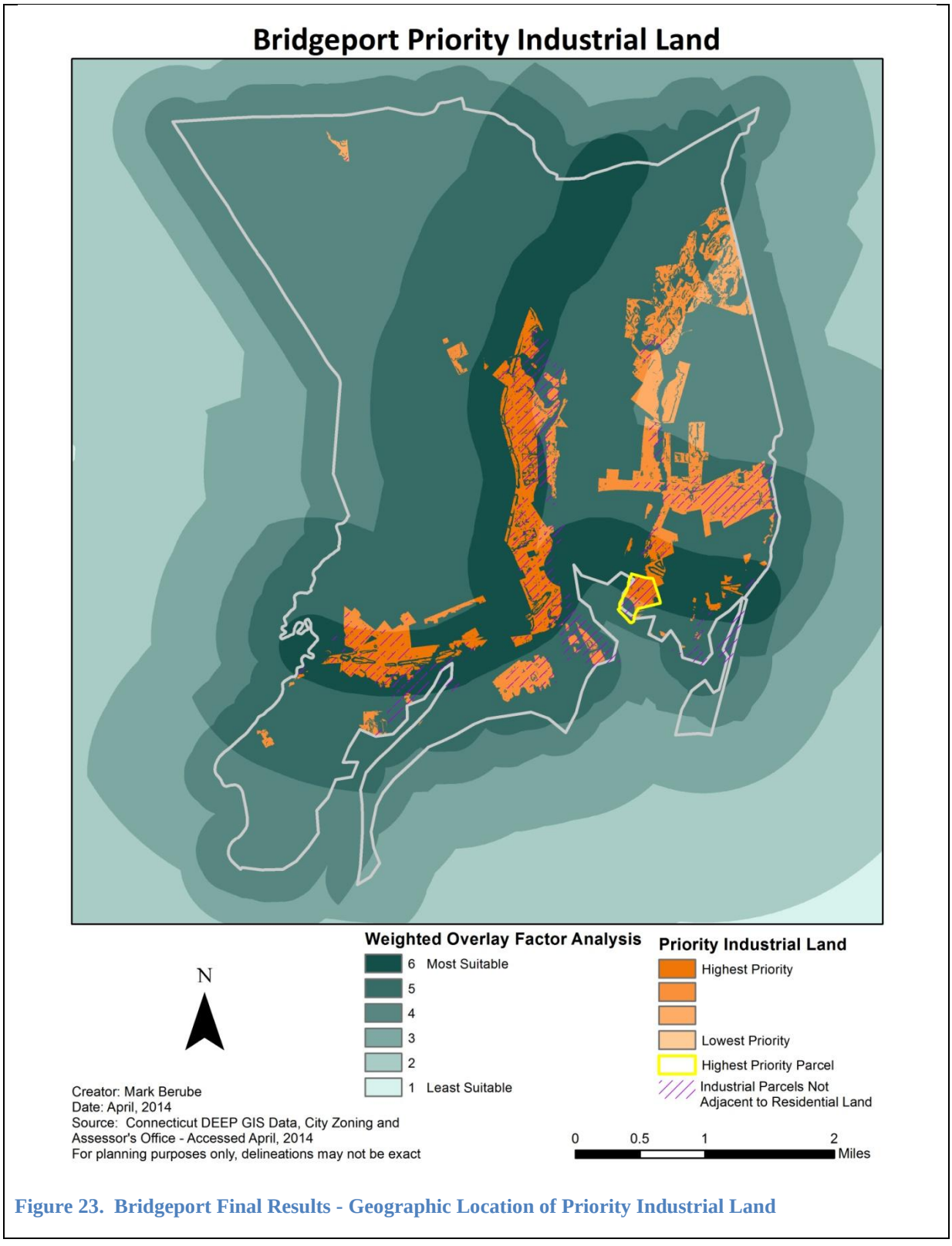

Figure 23. Bridgeport Final Results - Geographic Location of Priority Industrial Land

Figure 24. Hartford Final Results - Geographic Location of Priority Industrial Land

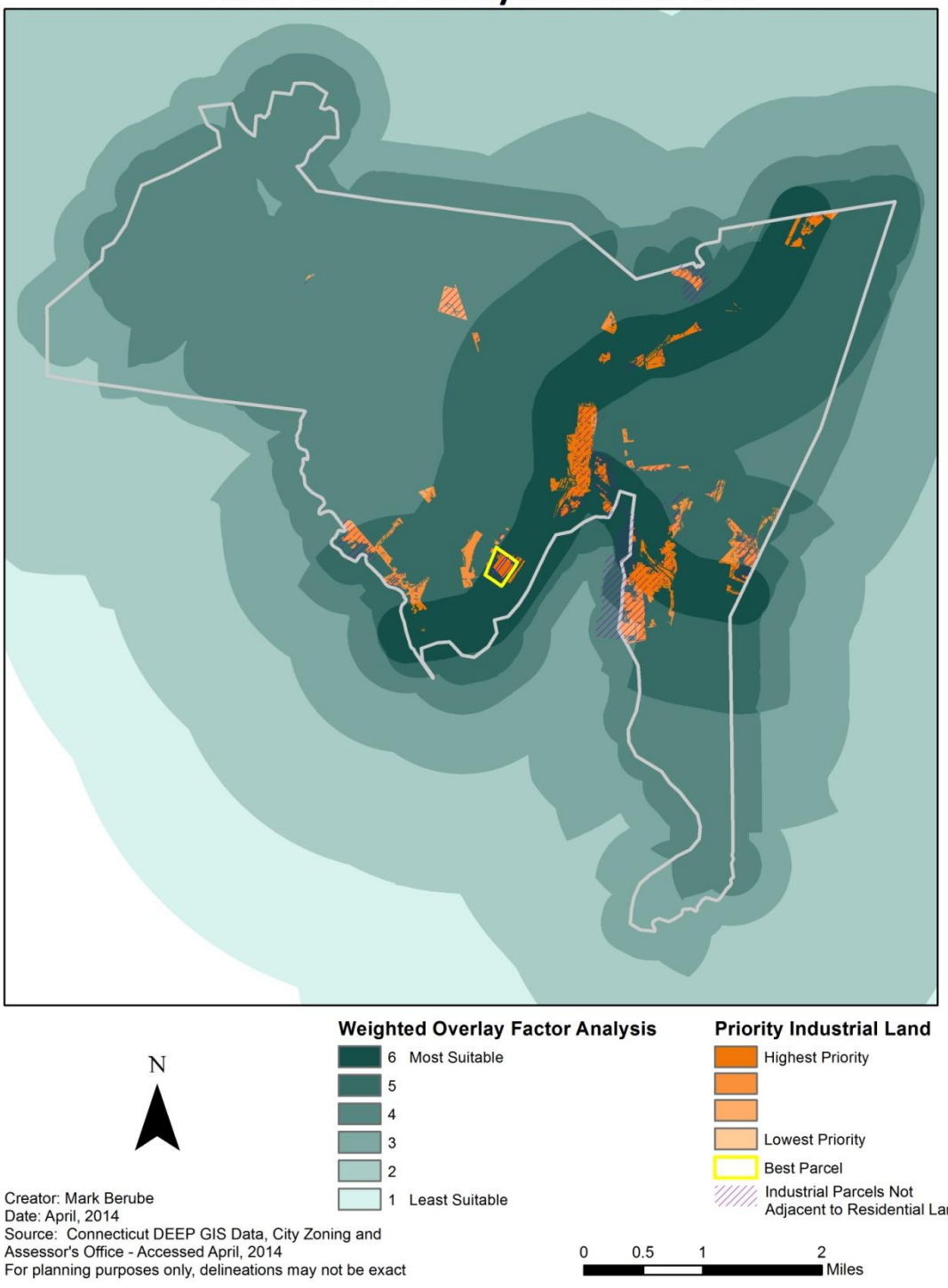

Figure 25. New Haven Final Results - Geographic Location of Priority Industrial Land

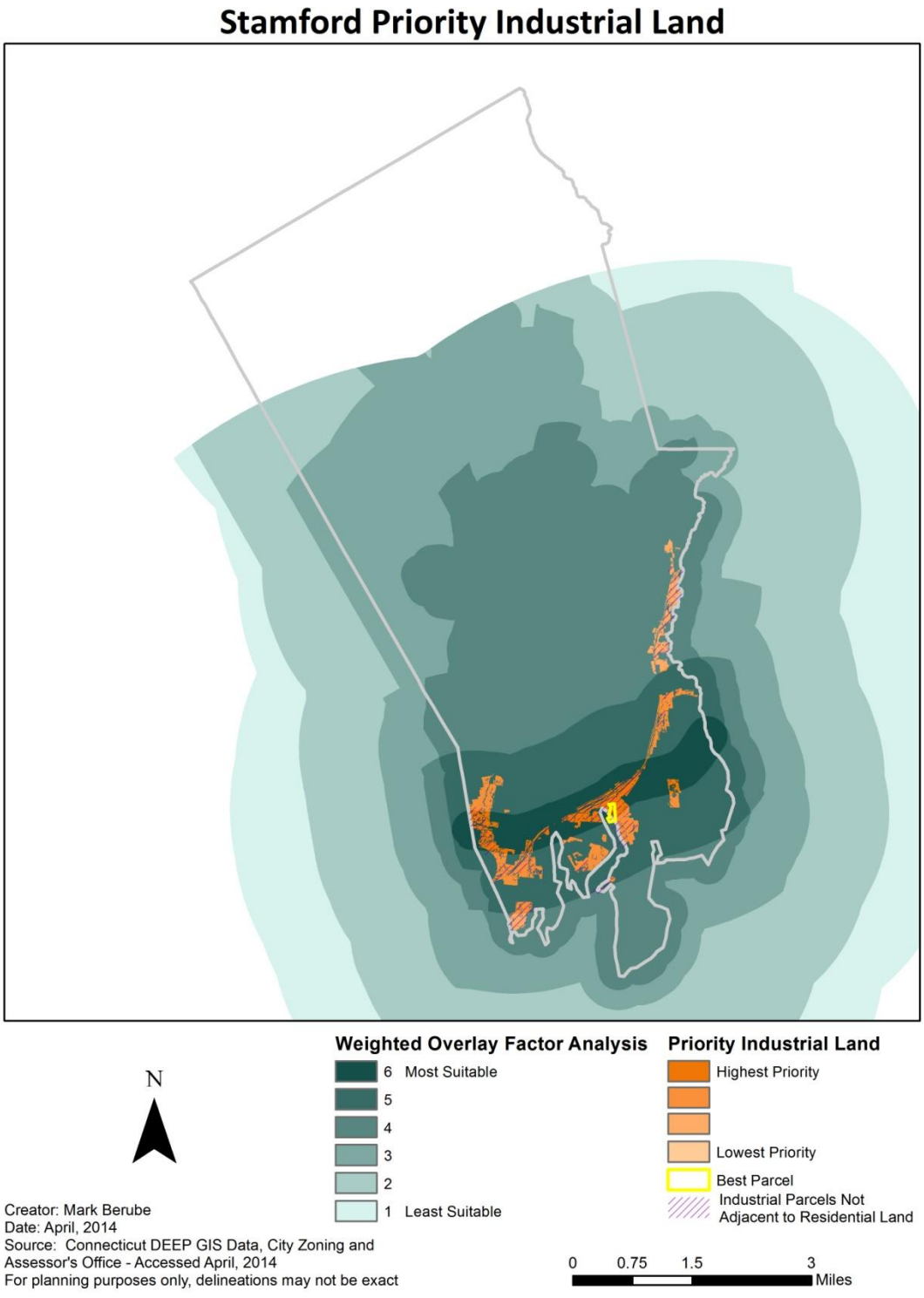

Figure 26. Stamford Final Results - Geographic Location of Priority Industrial Land

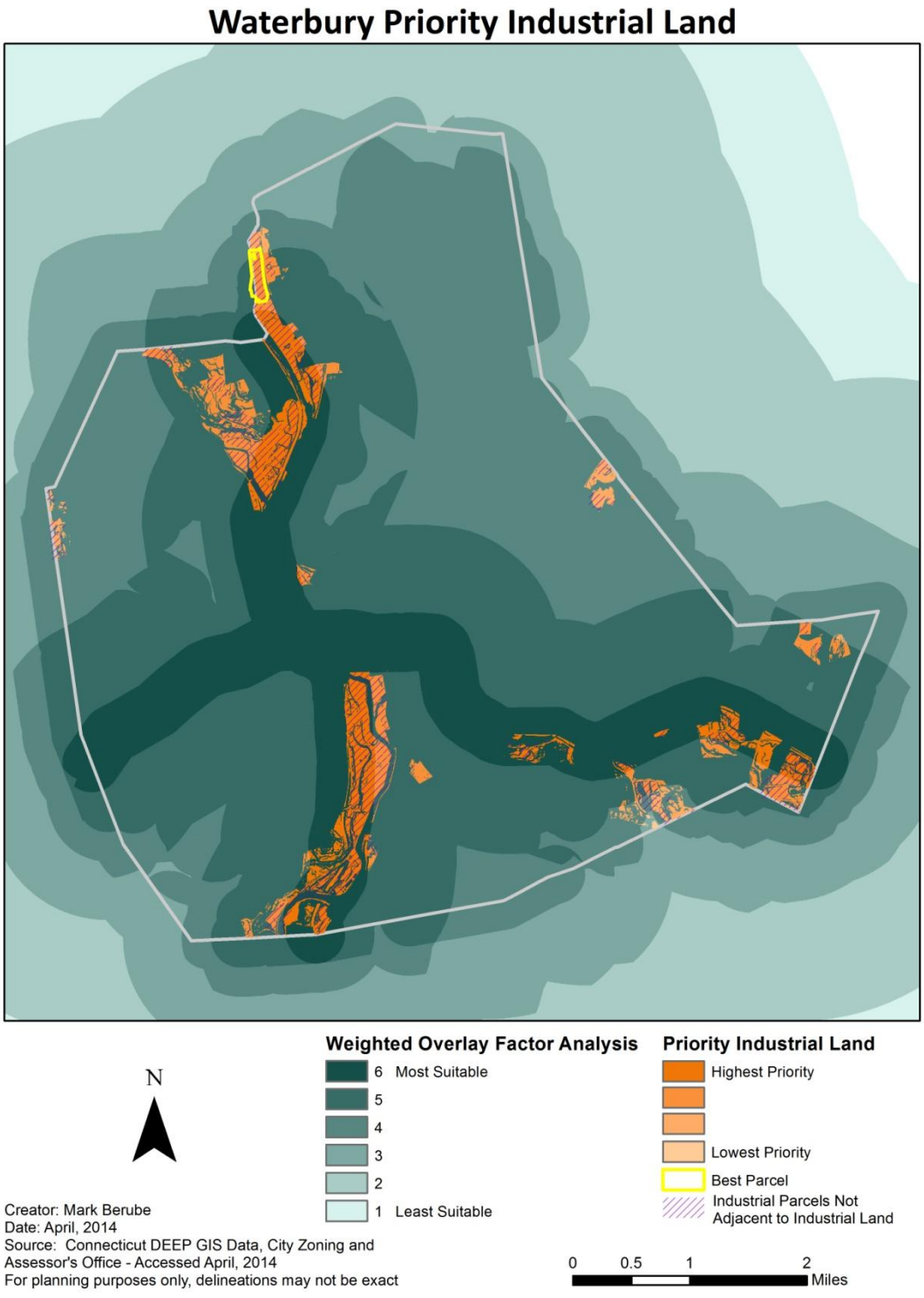

Figure 27. Waterbury Final Results - Geographic Location of Priority Industrial Land

Chapter 5. Research Results

Each Connecticut City retains industrial land for industrial activity. However, not all industrial parcels are active or suitable for development, and geography plays a critical role in determining viable locations for industrial business. Parcels with few or no environmental constraints, located in close proximity to amenities, are most suitable for industrial activity or protection for future industrialization. The following section discusses each city's priority locations produced by the GIS analysis. In addition to measuring the amount of priority developable industrial land, identifying one prime parcel within each community because of its key location, characteristics, and available developable industrial land helps further illustrate why these industrial parcels require protection and what characteristics to be aware of when searching for other priority locations. These sites are also larger than 10 acres and not adjacent to residential uses.

Table 13. Parcels Larger Than 10 Acres

City	# of Parcels larger than 10 Acres not Adjacent to Residential Property
Bridgeport	6
Hartford	29
New Haven	14
Stamford	5
Waterbury	14

Bridgeport

The City of Bridgeport designates 2,160 acres, or just over a fifth of city land, for industrial use. Two large districts surround the major highway systems (Interstate 95 and State Highway 8) and one smaller area occupies property in the eastern region of the city. After erasing environmental constraints from existing industrial districts, only 1,277 developable acres remain, indicating that almost 900 industrial acres are located within wetlands, flood zones, natural habitat protection areas, or have slopes greater than 15%.

Remaining industrial land, our input for the weighted overlay factor analysis, identifies priority industrial parcels. Thirty-nine percent, or 498 acres of Bridgeport's developable industrial land were classified as most suitable (zone 6), and 617 acres (48.4%) were classified as second most suitable (zone 5). In addition, only six parcels larger than ten acres encompass developable industrial land, and are not adjacent to residential uses.

Table 14. Bridgeport Suitable Industrial Acreage

		Suitability Classification			
Bridgeport		Most Suitable →			Least Suitable
	Total	**6**	**5**	**4**	**3**
Number of Cells	556,313	217,085	269,166	70,062	0
Developable Industrial Land (GIS Acres)	1,277.1	498.36	617.92	160.84	0.00
% of Total Developable Industrial Land	100%	39.0%	**48.4%**	12.6%	0.0%

The prime parcel identified above in Figure 24 and 25 below, on Seaview Avenue in Bridgeport, is considered to have the highest priority for protection. Compared to all other industrial parcels larger than 10 acres, this location is:

- Located within the most suitable location, Zone 6
- The entire parcel is situated on flat land
- Requires no demolition of antiquated structures
- Adjacent to interstate 95
- Very few environmental restrictions
- 42 Acres
- Easily accessible
- Surrounded by other industrial activity

Figure 28. Bridgeport Priority Parcel

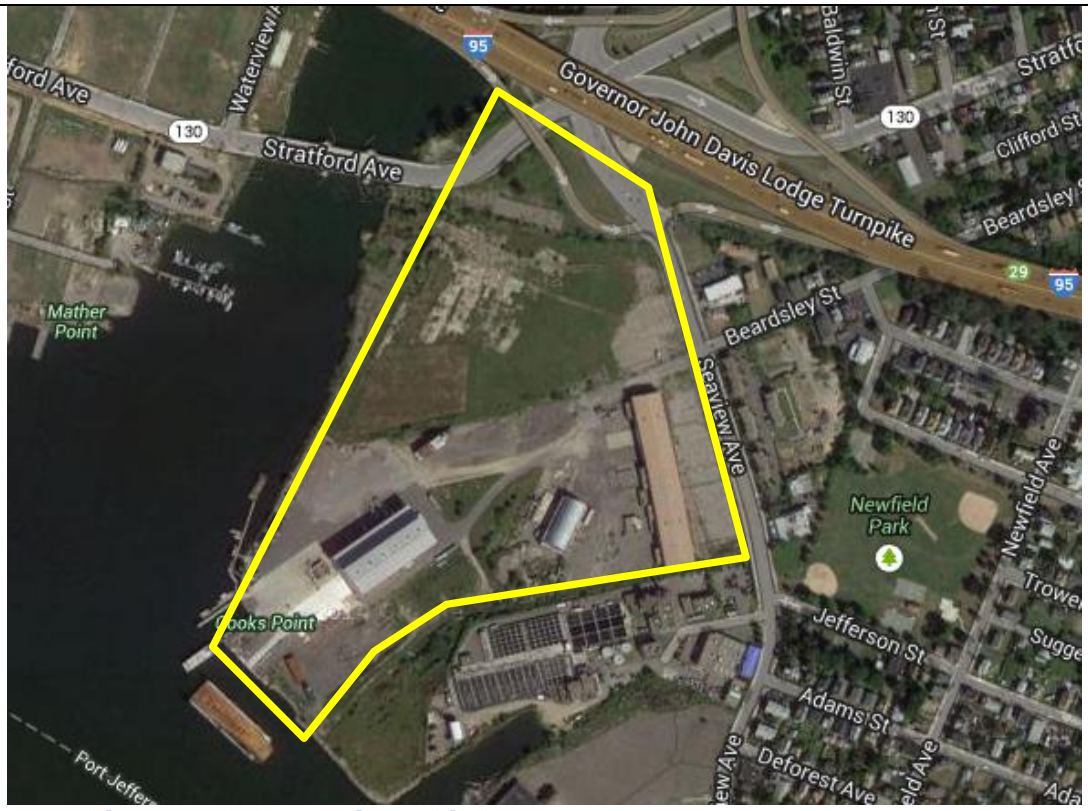

Figure 29. Bridgeport Priority Parcel - Aerial View

Source: Imagery©2014 DigitalGlobe, New York GIS, U.S. Geological Survey, USDA Farm Service Agency Map Data©2014 Google

Hartford

The State Capitol, Hartford, maintains 1,763 acres of industrial property, just 16% of the City's total land mass. These industrial parcels are prominent along Interstate 84 and 91, beyond the core business district. After completing the constraint analysis, 500 undevelopable acres are removed, yielding 1,282 acres suitable for development: 716 acres are classified as most suitable (zone 6), and 549 acres are second most suitable (zone 5). In addition, Hartford accounts for 29 parcels larger than 10 acres, not adjacent to residential zones, more than any other city.

Table 15. Hartford Suitable Industrial Acreage

Hartford	Total	Suitability Classification			
		Most Suitable →			Least Suitable
		6	5	4	3
Number of Cells	558,342	311,911	239,284	7,147	0
Developable Industrial Land (GIS Acres)	1,281.8	716.1	549	16	0
% of Total Developable Industrial Land	100%	**55.9%**	42.9%	1.3%	0.0%

The prime parcel identified below in Figure 26 and 27, on Reserve Road in Hartford, is considered to have the highest priority for protection. Of all other industrial parcels larger than 10 acres, this location is:

- Adjacent to Interstate 91 and a short distance from Interstate 84
- Situated on flat land
- The entire parcel is 100% free from environmental constraints
- Currently home to an active business
- 33 Acres
- Easily accessibly
- Surrounded by adjacent industrial uses

Figure 30. Hartford Priority Parcel

Figure 31. Hartford Priority Parcel - Aerial View

Source: Imagery©2014 DigitalGlobe, New York GIS, U.S. Geological Survey, USDA Farm Service Agency Map Data©2014 Google

New Haven

New Haven possesses 1,762 industrial acres, nearly 15% of the city's land mass. The city, however, designates a large quantity of this land for oil tank storage in the port of New Haven and the Metro North/Amtrak Rail System, which utilizes Union Station as a major hub for rail passengers. Remaining industrial districts situate themselves along the corridors of Interstate 91 and 95, and a few sparse parcels centrally located in the northern region of the city, are in less suitable districts. After removing all constraints, only 479 developable acres remain, signifying a 73% loss of industrial land due to environmentally sensitive conditions.

After the factor analysis is completed, the most suitable zone, 6, contains 233 acres, just below 50% of the city's developable industrial land. In addition, another 200 acres are classified as second most suitable (zone 5), and only 46 acres, or 9.7% of remaining industrial parcels, are situated furthest from critical amenities.

Table 16. New Haven Suitable Industrial Acreage

		Suitability Classification			
New Haven		Most Suitable →			Least Suitable
	Total	**6**	**5**	**4**	**3**
Number of Cells	208,945	101,810	86,926	20,209	0
Developable Industrial Land (GIS Acres)	479.7	233.7	200	46	0
% of Total Developable Industrial Land	100%	**48.7%**	41.6%	9.7%	0.0%

The prime parcel identified below in Figure 28 and 29, on Sargent Drive in New Haven, is considered to have the highest priority for protection. Of all other industrial parcels larger than 10 acres, this 30-acre site is:

- Located in the most suitable location, Zone 6
- Location of an established business
- Situated on flat land
- Adjacent to Interstate 95
- Easily accessible
- Few environmental constraints
- Surrounded by other industrial activity

Figure 32. New Haven Priority Parcel

Figure 33. New Haven Priority Parcel - Aerial View

Source: Imagery©2014 DigitalGlobe, New York GIS, U.S. Geological Survey, USDA Farm Service Agency Map Data©2014 Google

Stamford

Stamford industrial districts consume the smallest percentage of land than any other city, encompassing just 4% (967 acres) of property. Industrial districts are limited along Interstate 95 and one major corridor traversing the eastern boundary of the city. After removing all environmental constraints, 671 developable acres remain. The factor analysis then estimates 201.9 acres (30%) designated as most suitable, within zone 6. In addition, Stamford accounts for only 5 parcels larger than 10 acres, not adjacent to residential zones, fewer than any other city.

Table 17. Stamford Suitable Industrial Acreage

		Suitability Classification			
Stamford		Most Suitable →			Least Suitable
	Total	**6**	**5**	**4**	**3**
Number of Cells	292,481	87,937	152,431	52,113	0
Developable Industrial Land (GIS Acres)	671.4	201.9	350	120	0
% of Total Developable Industrial Land	100%	30.1%	**52.1%**	17.8%	0.0%

The prime parcel identified below in Figure 30 and 31, on Harborview Avenue in Stamford, is considered to have the highest priority for protection. Of all other industrial parcels larger than 10 acres, this 10-acre site is:

- Located in the most suitable location, Zone 6
- Location of established businesses
- Situated on flat land
- Adjacent to Interstate 95
- Easily accessible
- Few environmental constraints
- Surrounded by other industrial activity

Figure 34. Stamford Priority Parcel

Figure 35. Stamford Priority Parcel - Aerial View

Source: Imagery©2014 DigitalGlobe, New York GIS, U.S. Geological Survey, USDA Farm Service Agency Map Data©2014 Google

Waterbury

Waterbury maintains 1,905 acres of industrial property, just 10% of the City's total land mass. These industrial parcels are prominent along Interstate 84 and State Route 8/. After the constraint analysis removes approximately 800 undevelopable acres, yielding 1,082 acres suitable for development, 577.5 acres are classified as most suitable (zone 6), and 396 acres are second most suitable (zone 5). In addition, Waterbury accounts for 14 parcels larger than 10 acres, not adjacent to residential zones, more than any other city.

Table 18. Waterbury Suitable Industrial Acreage

		Suitability Classification			
Waterbury		Most Suitable →			Least Suitable
	Total	**6**	**5**	**4**	**3**
Number of Cells	471,399	251,568	172,541	46,070	1,220
Developable Industrial Land (GIS Acres)	1,082.5	577.5	396	106	3
% of Total Developable Industrial Land	100%	**53.4%**	36.6%	8.6%	0.2%

The prime parcel identified below in Figure 30 and 31, on Thomaston Avenue in Waterbury, is considered to have the highest priority for protection. Of all other industrial parcels larger than 10 acres, this 16-acre site is:

- Situated on flat land
- Adjacent to Interstate State Highway 8
- Easily accessible
- Few environmental constraints
- Surrounded by other industrial activity
- Currently in the process of revitalization and new development

Figure 36. Waterbury Priority Parcel

Figure 37. Waterbury Priority Parcel - Aerial View

Chapter 6. Conclusion

Cities can take advantage of future industrial activity, such as green technology, niche manufacturing, transportation and warehousing, or food distribution centers by identifying priority industrial property for future protection and investment. Redeveloping these vacant and often blighted industrial properties, however, is a time-consuming procedure and costly process. Therefore, developing an efficient strategy for inventorying and prioritizing existing industrial properties, most feasible for investment, expedites the redevelopment process.

Summary of Findings

A GIS Multi-criteria evaluation is a useful tool for inventorying industrial districts, while also prioritizing parcels for strategic economic development. The analysis categorized developable industrial land into six suitability classifications: locations identified by the highest value (6) were located within the most suitable zone, while the lowest value (1) designated the least suitable locations, situated furthest from critical amenities. In addition to the GIS analysis, a tax base analysis measured the value of industrial land and fiscal revenue generated from each city's land use categories. Finally, an employment forecast for the Connecticut manufacturing sector assesses future industrial activity according to past business and employment trends.

GIS ANALYSIS

This project identified priority industrial districts in each city with the intention of protecting these areas for future industrialization. After removing environmental constraints, each city lost a large percentage of their designated industrial zones due to the presence of wetlands, floodplains, natural habitat protection areas, and steep slopes. Eliminating these development restrictions allows a city to visualize where large contiguous and developable

industrial parcels are located. Maps displayed on previous pages depict the locations of these suitable districts. Bridgeport, Hartford and Waterbury retain the most developable industrial land, each covering over 1,000 acres: Hartford has 1,281 acres, Bridgeport has 1,277 acres, and Waterbury has 1,082 acres. On the other hand, New Haven and Stamford preserve much less, encompassing just 479 and 671 acres each, respectively. Although New Haven possesses a large volume of designated industrial land (1,762 acres), only 27% is free from environmental restrictions. Stamford, however, has the least amount of designated industrial land, but maintains more than 70% as developable for future industrial uses. Nonetheless, these small volumes of industrial land require city officials and planners to scrutinize the future uses of these areas.

In order to determine which parcels are most important to protect and revitalize, the weighted overlay factor analysis evaluated four different criteria: proximity to major highways, sewer service areas, fiber-optic service areas, and public transportation. The location of industrial land within proximity to each amenity determines suitability. Based on the analysis, Hartford, New Haven, and Waterbury have approximately half or more of their current developable industrial land located in the highest priority zone (6): Hartford has 716 priority acres (55.4%), New Haven has 233 acres (48.7%), and Waterbury has 577 acres (53.4%) classified as most suitable for protection and investment. Bridgeport and Stamford have slightly less than the other cities, yielding 498 acres (39%) and 201 acres (30.1%), respectively. These locations are all within a quarter mile of each factor. Protecting these areas of land for future industrial activity suggests that other, less suitable industrial parcels, are insignificant due to their location to industrial amenities, and therefore, have potential as

alternative uses. Nonetheless, future industry should utilize these parcels if required in the future.

TAX BASE ANALYSIS

The purpose of the tax base analysis was to measure the change in property values between 1995 and 2010, in order to determine if industrial land revenue is declining while residential and commercial values grow. Based on the data, two of the five cities, Bridgeport and Stamford, experienced slight industrial growth over the past 15 years. However, residential tax revenue continued to rise as well, and commercial was the only category to experience an overall decline. On the contrary, Hartford, New Haven, and Waterbury reported industrial revenue losses, while residential and commercial revenues increased simultaneously. Nonetheless, each city increasingly depends on residential property to sustain their fiscal budgets.

From a planning perspective, a tax base that benefits from thriving industrial property effectively supports community services and public needs without increasing residential density. A growing residential population, consequently, increases costs associated with libraries, road maintenance, schools, or social services, etc. Planners must balance population growth while protecting industrial land by identifying locations for housing and commercial opportunities where such activities belong, without redeveloping priority industrial land.

A benefit of securing industrial land for industrial activity also prevents existing firms from relocating to outside communities. The implementation of a land bank, in this matter, maintains property values and mitigates residential and commercial real estate pressure. When real estate values rise, it becomes difficult for industrial firms to thrive within a community, displacing businesses to locations where land values or tax rates are less expensive.

ECONOMIC OUTLOOK

Between 2002 and 2012, Connecticut manufacturing experienced a large decline in total employment and total number of firms within each city. During this ten-year period, Connecticut manufacturers laid off nearly 46,000 employees, and each city lost anywhere from 10.9% to 35.7% of their manufacturing firms. According to trends and future employment projections (computed for the workforce investment areas home to each city), calculations predict slight changes through the year 2020. Unfortunately, Connecticut will continue to lose manufacturing jobs within each WIA; however, the decrease is marginal, as the State on average will lose just 2.3% of their job base by the end of this decade. Despite this outlook, by 2011, Connecticut manufacturing workforce trends illustrated surprising vitality, in which 8,000 more jobs were available than originally projected (Lanza 2013).

Despite Connecticut's slow economy, the United States manufacturing industry is improving. Manufacturing firms added 250,000 jobs since its low point in December 2009, and the U.S. remains one of the largest manufacturing economies in the world; in 2010, 21% of the world's goods manufactured in the States increased its GDP value from 11.7% to 21.3% over the last decade, ranking 10th amongst all other states (Leigh and Hoelzel 2012, 88). These recent data indicate potential industrial growth and motivation for protecting industrial land.

Measuring future employment opportunities is critical for industrial land protection. If economic activity within the industrial sector begins to grow, land is required for businesses and industrialization in the future. Planners and developers utilizing industrial land for something other than manufacturing, warehousing, or research and development greatly limits the potential for a city to take advantage of new technologies and potential job creation and

economic wealth. As a result, a positive job outlook infers that residents will need opportunities for employment, especially in cities where staggering unemployment and poverty rates exist.

Limitations and Future Research

The GIS model utilized for this project, although efficient for inventorying and visualizing the location of priority industrial districts, has potential for improvement. During the analysis, a consistent procedure and various data limitations prevented the tool from enhancing the identification of priority industrial land. Added data inputs, including constraints and factors, however, can refine the output, which ultimately improves the decision making process for city officials and planners.

Selecting development constraints is a critical first step to identifying developable land. In order to develop a consistent GIS methodology, the analysis evaluated each community by a consistent statewide dataset acquired from the Connecticut DEEP. This data, although relevant, did not take into account local regulations and specific site characteristics. Therefore, refining the constraint analysis and creating a more detailed inventory of developable industrial land requires the implementation of specific development constraints, city zoning policies, and environmental regulations. For example, a supplemental analysis should evaluate each city's industrial districts individually according to explicit zoning policies that measure floor area ratio (FAR) for each parcel, building setbacks, and specific industrial uses allowed within each zone. In addition, communities may implement stringent environmental regulations that further prevent certain types of development and activity. Identifying these development policies may refine the amount of available developable land, altering the final output generated by the GIS.

Implementing new factors also improve the GIS analysis. Due to data limitations and information sensitivity, the procedure was unable to account for all amenities critical for industrial activity, specifically, clean water and natural gas location data. These utilities are assets to firms because of their ability to augment the industrial process and decrease energy usage, reducing the cost to do business. Specific location data, however, were unavailable from their original sources. Nonetheless, we are able conclude that each city has available natural gas service according to the Connecticut Natural Gas website and water utilities even though the company itself does not furnish the specific location of infrastructure.

For future research, the GIS analysis can modify specific inputs for individual business needs. Initially, the weighted overlay analysis utilized one set of weighted values to measure the importance of each factor. The results produced one generalized output for all industrial districts. However, some businesses may require different inputs for individual factors, creating a more personalized analysis. For example, a firm requiring fiber-optic service can modify the analysis to define specific locations most suitable according to the proximity of that individual amenity. Therefore, this versatile model enhances location-based decisions for future development and investment.

In addition to modifying the analysis for individual business needs, identifying commercial and residential real estate pressure, and land use change depicting industrial zoning conversions, helps planners determine which parcels require additional protection. Surrounding land use change and rising values indicate a changing neighborhood and the possibility of deindustrialization. Therefore, securing industrial land for future industrial activity, based on this research method, prevents property values from rising and potentially displacing industrial businesses. Implementing a land bank for protecting specific parcels

also establishes that these properties will not change for future uses, preventing planners and developers from encouraging zoning changes, which encourage industrial disinvestment.

Recommendations for Industrial Land Protection

Policy makers and local governments foster redevelopment of industrial districts by establishing an industrial land bank for cities experiencing industrial blight. According to the U.S. Department of Housing and Urban Development (HUD), "A land bank is a governmental or nongovernmental nonprofit entity established, at least in part, to assemble, temporarily manage, and dispose of vacant land for the purpose of stabilizing neighborhoods and encouraging re-use or redevelopment of urban property." The city's goal is to identify vacant or deteriorating properties unsuitable for development, due to zoning policies or lack of amenities, and protect them for future redevelopment because of their ability to create jobs, diversify the tax base, and revitalize neighborhoods. A land bank also maintains and stabilizes the local real estate market; the strategy prevents property sharks from investing in industrial land with the hope of city officials or planners rezoning it within the future.

Similar to the objective of this project, a land bank inventories and identifies priority industrial property most suitable for redevelopment and capable of retaining and growing manufacturing or industrial jobs. Specific attributes enhance a city's ability to prioritize suitable industrial districts due to their feasibility for redevelopment and investment. A set of characteristics can help determine which parcels best meet community's goals and objectives, and forward revitalization in an efficient manner. Cities must take into account several characteristics that highlight these critical industrial locations:

- Properties are adjacent or contiguous with other existing industrial and commercial land owners
- Properties are within existing urban infrastructure

- Properties are in proximity to highway access, water and sewer service areas, fiber-optic service areas, and natural gas service areas
- Parcels are suitable for development; few environmental constraints exist
- Lots are large in size; or contiguous parcels can be acquired and assembled into larger districts
- Parcels are identified in city master plans and economic development strategies
- Ease of access to the site

A land bank is capable of maintaining industrial land and protecting it for future development with the intent to revitalize and enhance a community's vibrancy. A successful land bank, however, first requires a city to prioritize and implement specific strategies suitable for local stakeholders. Most importantly, a working private-public partnership is critical to allocating necessary resources and capital, which contribute to the long-term success of a land bank. In addition, a transparent process allows successful revitalization and coordination throughout the development of a project, and reduces any complexity associated with redevelopment, zoning policies, and site remediation. Lastly, inventorying each industrial district is also vital, as it improves the decision-making process and streamlines investment. Cities capable of researching and analyzing suitable properties for individual business needs can increase project efficiency. Implementing a land bank and a GIS analysis to not only map, but also identify priority locations, can help bring feasible projects into fruition.

Appendix A

Real Property Tax Revenue

State of Connecticut Office of Policy and Management

Bridgeport Real Property Tax Revenue, State of Connecticut OPM Grand Lists 1995-2010

Year	Residential	Commercial	Industrial	Public Utility	Vacant	Land	Apartment	Residential & Apartment	Total
1995	$ 1,874,971,046	$ 700,401,352	$ 218,969,275	$ 27,483,556	$ 24,996,918	$ -	n/a	$ 1,874,971,046	$ 2,846,822,147
1996	$ 1,825,545,326	$ 715,331,552	$ 209,523,234	$ 13,073,529	$ 26,239,685	$ -	n/a	$ 1,825,545,326	$ 2,789,713,325
1997	$ 1,778,582,313	$ 690,557,227	$ 201,248,108	$ 23,861,288	$ 26,768,717	$ -	n/a	$ 1,778,582,313	$ 2,743,302,009
1998	$ 1,806,792,155	$ 522,125,533	$ 197,788,532	$ 23,802,114	$ 26,448,214	$ -	$ 183,755,431	$ 1,990,547,585	$ 2,760,711,978
1999	$ 1,718,548,511	$ 529,290,332	$ 177,763,259	$ 37,943,178	$ 25,901,763	$ -	$ 170,496,056	$ 1,889,044,567	$ 2,659,943,098
2000	$ 2,688,807,262	$ 750,976,427	$ 232,959,289	$ 34,108,150	$ 42,947,743	$ -	$ 267,268,289	$ 2,956,075,551	$ 4,017,067,160
2001	$ 2,628,364,595	$ 726,200,515	$ 220,330,191	$ 33,355,764	$ 54,271,967	$ -	$ 253,724,053	$ 2,882,088,648	$ 3,916,247,086
2002	$ 2,604,558,937	$ 708,018,241	$ 203,344,043	$ 34,154,219	$ 46,008,314	$ -	$ 246,759,413	$ 2,851,318,350	$ 3,842,843,166
2003	$ 4,060,359,323	$ 897,491,255	$ 240,372,334	$ 40,791,505	$ 54,260,626	$ -	$ 354,011,918	$ 4,414,371,241	$ 5,647,286,961
2004	$ 3,946,773,190	$ 895,260,696	$ 233,755,746	$ 39,830,939	$ 50,929,715	$ -	$ 339,919,236	$ 4,286,692,426	$ 5,506,469,521
2005	$ 3,839,530,636	$ 863,965,180	$ 226,357,721	$ 49,261,234	$ 49,324,933	$ -	$ 334,246,950	$ 4,173,777,586	$ 5,362,686,653
2006	$ 3,747,404,628	$ 877,743,099	$ 209,818,374	$ 47,927,215	$ 42,850,017	$ -	$ 322,529,020	$ 4,069,933,648	$ 5,248,272,354
2007	$ 3,681,609,411	$ 842,014,443	$ 193,237,695	$ 46,679,779	$ 39,865,984	$ -	$ 317,585,398	$ 3,999,194,810	$ 5,120,992,711
2008	$ 4,455,957,339	$ 993,543,827	$ 317,322,969	$ 45,979,590	$ 86,341,787	$ -	$ 329,903,171	$ 4,785,860,510	$ 6,229,048,684
2009	$ 4,452,248,574	$ 1,005,742,871	$ 630,608,806	$ 45,966,788	$ 82,658,515	$ -	$ 372,243,993	$ 4,824,492,566	$ 6,589,469,546
2010	$ 4,418,491,585	$ 967,330,251	$ 614,148,399	$ 45,545,074	$ 81,603,222	$ -	$ 294,563,281	$ 4,713,054,866	$ 6,421,681,812

Hartford Real Property Tax Revenue, State of Connecticut OPM Grand Lists 1995-2010

Year	Residential	Commercial	Industrial	Public Utility	Vacant	Land	Apartment	Residential & Apartment	Total
1995	$ 2,342,300,453	$ 4,277,545,010	$ 437,220,060	$ 151,483,702	$ 329,777,987	$ -	n/a	$ 2,342,300,453	$ 7,538,327,212
1996	$ 2,276,467,665	$ 4,126,472,955	$ 422,458,965	$ 147,720,420	$ 320,253,465	$ -	n/a	$ 2,276,467,665	$ 7,293,373,470
1997	$ 2,208,488,462	$ 3,961,646,534	$ 400,614,933	$ 140,953,335	$ 310,890,940	$ -	n/a	$ 2,208,488,462	$ 7,022,594,204
1998	$ 2,201,725,114	$ 3,082,343,123	$ 386,245,657	$ 141,156,611	$ 320,443,019	$ -	$ 854,539,796	$ 3,056,264,910	$ 6,986,453,320
1999	$ 1,253,313,725	$ 1,710,074,862	$ 109,057,479	$ 75,982,813	$ 102,446,159	$ 24,872	$ 364,327,762	$ 1,617,641,487	$ 3,615,227,672
2000	$ 1,200,508,058	$ 1,676,950,441	$ 102,840,194	$ 73,288,387	$ 85,274,353	$ 23,990	$ 349,641,976	$ 1,550,150,033	$ 3,488,527,399
2001	$ 1,176,669,801	$ 1,647,202,476	$ 99,322,925	$ 43,094,873	$ 81,860,689	$ 23,461	$ 345,683,138	$ 1,522,352,939	$ 3,393,857,362
2002	$ 1,163,697,283	$ 1,655,057,630	$ 99,499,360	$ 39,423,481	$ 78,657,692	$ 23,108	$ 354,885,444	$ 1,518,582,727	$ 3,391,243,999
2003	$ 1,146,840,070	$ 1,587,799,890	$ 89,443,878	$ 34,860,314	$ 81,335,090	$ 22,579	$ 340,556,987	$ 1,487,397,057	$ 3,280,858,808
2004	$ 1,127,179,451	$ 1,528,505,823	$ 91,674,356	$ 33,770,929	$ 80,039,573	$ 21,874	$ 319,971,588	$ 1,447,151,038	$ 3,181,163,592
2005	$ 1,092,417,922	$ 1,509,806,710	$ 90,917,544	$ 31,089,576	$ 74,257,504	$ 21,168	$ 338,774,309	$ 1,431,192,230	$ 3,137,284,732
2006	$ 748,752,851	$ 1,491,892,058	$ 92,274,954	$ 29,214,948	$ 76,198,122	$ -	$ 350,157,365	$ 1,098,910,216	$ 2,788,490,297
2007	$ 1,182,165,987	$ 1,674,728,522	$ 105,122,283	$ 29,062,753	$ 106,471,999	$ 23,640	$ 539,531,390	$ 1,721,697,377	$ 3,637,106,573
2008	$ 990,303,979	$ 1,579,329,082	$ 101,575,814	$ 24,104,925	$ 101,145,666	$ 21,456	$ 447,770,911	$ 1,438,074,891	$ 3,244,251,833
2009	$ 924,636,386	$ 1,583,841,250	$ 98,691,875	$ 24,104,925	$ 101,277,797	$ 20,111	$ 417,003,247	$ 1,341,639,632	$ 3,149,575,590
2010	$ 870,799,141	$ 1,570,206,919	$ 93,129,904	$ 22,291,295	$ 97,983,073	$ 18,598	$ 395,422,233	$ 1,266,221,374	$ 3,049,851,163

New Haven Real Property Tax Revenue, State of Connecticut OPM Grand Lists 1995-2010

Year	Residential	Commercial	Industrial	Public Utility	Vacant	Land	Apartment	Total
1995	$ 2,673,225,031	$ 2,006,039,158	$ 280,919,778	$ 162,610,294	$ 84,428,806	$ 7,900	n/a	$ 5,207,230,967
1996	$ 2,471,670,251	$ 1,898,439,293	$ 270,351,240	$ 132,161,348	$ 82,470,656	$ 4,485	n/a	$ 4,855,097,271
1997	$ 2,516,693,335	$ 1,795,487,678	$ 246,365,174	$ 121,202,097	$ 80,866,922	$ 4,365	n/a	$ 4,760,619,572
1998	$ 2,507,976,954	$ 1,804,364,373	$ 236,306,262	$ 92,238,369	$ 81,543,044	$ 4,365	$ -	$ 4,722,433,367
1999	$ 2,427,272,104	$ 1,697,892,441	$ 230,934,430	$ 95,753,192	$ 50,043,845	$ 4,216	$ -	$ 4,501,900,228
2000	$ 2,393,443,170	$ 1,171,607,643	$ 230,730,765	$ 92,311,652	$ 46,039,711	$ 4,066	$ 386,355,555	$ 4,320,492,563
2001	$ 2,388,234,477	$ 1,086,990,872	$ 327,542,651	$ 82,627,553	$ 69,712,442	$ 95,893	$ 526,688,951	$ 4,481,892,839
2002	$ 2,345,187,833	$ 1,628,947,220	$ 322,427,837	$ 81,385,034	$ 64,220,628	$ 94,451	$ -	$ 4,442,263,003
2003	$ 2,292,332,045	$ 1,565,920,870	$ 305,753,907	$ 79,831,181	$ 60,493,798	$ 92,288	$ -	$ 4,304,424,090
2004	$ 2,234,557,984	$ 1,595,521,417	$ 284,792,710	$ 77,261,027	$ 53,065,093	$ 89,404	$ -	$ 4,245,287,634
2005	$ 2,183,278,344	$ 1,550,952,192	$ 278,230,596	$ 40,308,468	$ 47,846,904	$ 86,520	$ -	$ 4,100,703,024
2006	$ 3,957,220,694	$ 2,179,405,158	$ 324,264,811	$ 47,586,854	$ 71,092,549	$ 211,201	$ -	$ 6,579,781,267
2007	$ 3,874,600,884	$ 2,181,535,133	$ 314,513,544	$ 46,078,756	$ 68,749,844	$ 4,814	$ -	$ 6,485,482,975
2008	$ 3,746,454,718	$ 2,001,224,789	$ 295,875,148	$ 43,370,828	$ 67,289,046	$ 4,643	$ -	$ 6,154,219,172
2009	$ 3,755,393,381	$ 1,580,700,315	$ 314,108,744	$ 41,965,534	$ 69,607,585	$ 4,643	$ 575,846,499	$ 6,337,626,701
2010	$ 3,857,752,255	$ 2,172,418,866	$ 310,414,583	$ 42,598,105	$ 61,409,059	$ 4,601	$ -	$ 6,444,597,469

Stamford Real Property Tax Revenue, State of Connecticut OPM Grand Lists 1995-2010

Year	Residential	Commercial	Industrial	Public Utility	Vacant	Land	Apartment	Residential & Apartment	Total
1995	$ 7,443,720,715	$ 3,481,619,449	$ 290,664,189	$ 66,955,766	$ 1,583,474	$ 2,966,656	n/a	$ 7,443,720,715	$ 11,287,510,249
1996	$ 7,280,600,385	$ 3,458,692,245	$ 251,908,695	$ 63,931,980	$ 1,542,345	$ 2,889,600	n/a	$ 7,280,600,385	$ 11,059,565,250
1997	$ 7,125,244,585	$ 3,325,979,207	$ 234,241,130	$ 62,227,127	$ 1,501,216	$ 2,810,807	n/a	$ 7,125,244,585	$ 10,752,004,071
1998	$ 7,216,324,568	$ 2,752,479,126	$ 290,627,688	$ 72,154,091	$ 4,465,016	$ 1,540,767	$ 407,256,926	$ 7,623,581,494	$ 10,744,848,180
1999	$ 8,492,703,455	$ 3,663,344,286	$ 312,733,700	$ 77,849,089	$ 5,178,986	$ 1,555,019	$ 655,055,262	$ 9,147,758,717	$ 13,208,419,797
2000	$ 8,233,676,246	$ 3,515,382,781	$ 290,105,490	$ 75,088,497	$ 4,995,334	$ 1,500,828	$ 660,030,902	$ 8,893,707,148	$ 12,780,780,078
2001	$ 8,100,926,393	$ 3,491,582,181	$ 213,084,221	$ 68,711,497	$ 1,474,983	$ 7,936,416	$ 716,268,308	$ 8,817,194,701	$ 12,599,983,999
2002	$ 8,016,746,832	$ 3,459,742,580	$ 215,348,529	$ 52,036,632	$ 1,129,377	$ 10,804,749	$ 735,735,614	$ 8,752,482,446	$ 12,491,544,313
2003	$ 7,913,149,862	$ 3,060,292,160	$ 530,992,986	$ 50,288,627	$ -	$ 541,005	$ 709,020,493	$ 8,622,170,355	$ 12,264,285,133
2004	$ 7,760,763,324	$ 2,946,281,664	$ 509,624,574	$ 48,717,120	$ -	$ 491,548	$ 685,104,848	$ 8,445,868,172	$ 11,950,983,079
2005	$ 7,613,480,472	$ 2,879,571,228	$ 452,020,632	$ 47,472,744	$ -	$ 448,536	$ 661,641,300	$ 8,275,121,772	$ 11,654,634,912
2006	$ 15,916,703,395	$ 4,491,179,737	$ 842,173,375	$ 119,381,945	$ -	$ 392,022	$ 1,204,807,471	$ 17,121,510,866	$ 22,574,637,945
2007	$ 15,953,273,127	$ 6,810,942,587	$ 1,061,901,578	$ 75,315,540	$ -	$ 756,885	$ 1,364,717,170	$ 17,317,990,297	$ 25,266,906,887
2008	$ 15,501,452,418	$ 6,545,535,312	$ 949,818,021	$ 68,142,113	$ -	$ 729,755	$ 1,389,868,352	$ 16,891,320,770	$ 24,455,545,972
2009	$ 15,700,983,829	$ 6,570,538,357	$ 913,397,568	$ 68,142,113	$ -	$ 729,755	$ 1,332,992,512	$ 17,033,976,341	$ 24,586,784,133
2010	$ 15,630,015,895	$ 6,385,186,860	$ 899,418,611	$ 57,191,346	$ -	$ 744,638	$ 1,307,545,675	$ 16,937,561,570	$ 24,280,103,026

Waterbury Real Property Tax Revenue, State of Connecticut OPM Grand Lists 1995-2010

Year	Residential	Commercial	Industrial	Public Utility	Vacant	Land	Apartment	Residential & Apartment	Total
1995	$ 980,774,388	$ 521,368,133	$ 160,672,161	$ 13,281,884	$ 24,062,669	$ 72,334	n/a	$ 980,774,388	$ 1,700,231,570
1996	$ 955,116,092	$ 517,628,861	$ 154,189,038	$ 12,935,010	$ 28,554,230	$ 70,455	n/a	$ 955,116,092	$ 1,668,493,685
1997	$ 932,521,164	$ 563,059,065	$ 149,895,502	$ 12,651,104	$ 21,647,132	$ 65,218	n/a	$ 932,521,164	$ 1,679,839,186
1998	$ 935,013,092	$ 433,183,440	$ 149,721,937	$ 12,651,104	$ 21,233,325	$ 65,218	$ 135,566,866	$ 1,070,579,958	$ 1,687,434,982
1999	$ 905,387,242	$ 418,257,098	$ 145,824,318	$ 12,217,847	$ 20,546,454	$ 62,745	$ 125,557,762	$ 1,030,945,003	$ 1,627,853,466
2000	$ 874,685,899	$ 405,128,523	$ 141,022,915	$ 11,784,590	$ 22,806,388	$ 60,520	$ 117,880,466	$ 992,566,364	$ 1,573,369,301
2001	$ 2,285,961,679	$ 1,022,029,496	$ 223,402,667	$ 16,656,056	$ 97,329,280	$ 73,070	$ -	$ 2,285,961,679	$ 3,645,452,248
2002	$ 2,398,354,851	$ 785,204,568	$ 212,427,085	$ 16,948,177	$ 92,053,766	$ 274,904	$ 200,813,463	$ 2,599,168,315	$ 3,706,076,814
2003	$ 2,357,314,738	$ 769,285,734	$ 204,659,661	$ 14,785,702	$ 79,102,797	$ 270,131	$ 196,905,587	$ 2,554,220,325	$ 3,622,324,351
2004	$ 2,351,826,904	$ 824,820,766	$ 168,573,955	$ 134,978	$ 12,442,543	$ 228,507	$ 184,453,509	$ 2,536,280,413	$ 3,542,481,162
2005	$ 2,292,869,630	$ 818,211,008	$ 162,477,658	$ 130,624	$ 12,404,639	$ 256,416	$ 177,414,144	$ 2,470,283,774	$ 3,463,764,119
2006	$ 2,234,824,338	$ 839,742,233	$ 156,015,532	$ 126,269	$ 12,166,230	$ 187,943	$ 194,936,615	$ 2,429,760,953	$ 3,437,999,160
2007	$ 3,452,069,158	$ 1,186,247,054	$ 153,541,213	$ 103,979,572	$ 81,706,108	$ -	$ 329,864,560	$ 3,781,933,718	$ 5,307,407,664
2008	$ 3,344,795,462	$ 1,152,064,689	$ 146,350,692	$ 95,595,060	$ 71,355,389	$ 90,699	$ 358,541,482	$ 3,703,336,944	$ 5,168,793,473
2009	$ 3,352,241,176	$ 1,142,115,348	$ 145,421,511	$ 93,166,311	$ 75,585,080	$ 138,343	$ 321,626,824	$ 3,673,868,000	$ 5,130,294,593
2010	$ 3,330,478,173	$ 1,126,674,411	$ 143,626,245	$ 92,438,496	$ 78,697,164	$ 349,628	$ 296,621,739	$ 3,627,099,912	$ 5,068,885,855

Bibliography

Alonso, William. 1964. "The Historic and the Structural Theories of Urban Form: Their Implications for Urban Renewal." *Land Economics* 40 (2): 227-231.

American Farmland Trust. August 2010. *Costs of Community Services Studies*. Northampton, Massachusetts: American Farmland Trust.

Bowen Jr, J. T. 2008. Moving places: the geography of warehousing in the US. *Journal of Transport Geography*, *16* (6), 379-387.

Bronstein, Zelda. 2009. "Industry and the Smart City." *Dissent* 56 (3): 27-34.

Byron, Joan and Nisha Mistry. April 2011. *The Federal Role in Supporting Urban Manufacturing*. Washington DC: Brookings Institute.

Connecticut Office of Policy and Management. 2013. *Conservation and Development Policies: The Plan for Connecticut*. Hartford, Connecticut: State of Connecticut.

Connecticut Regulatory Statutes. "Chapter 440 Wetlands and Watercourses Act Cited.211 C. 416; 227 C.71." Legislation, Regulation and Case Law. State of Connecticut, last modified December 23 2013, accessed March 4, 2014, http://www.ct.gov/deep/cwp/view.asp?a=2720&q=419590&deepNav_GID=1907

Crosetto, Michele, Stefano Tarantola, and Andrea Saltelli. 2000. "Sensitivity and Uncertainty Analysis in Spatial Modelling Based on GIS." *Agriculture, Ecosystems & Environment* 81 (1): 71-79.

Federal Emergency Management Agency. "Flood Zones." Federal Emergency Management Agency, last modified September 4 2013, accessed March 8, 2014, http://www.fema.gov/floodplain-management/flood-zones.

Federal Highway Administration. 2014. "U.S. Department of Transportation." Planning Glossary. accessed April 9, 2014, http://www.fhwa.dot.gov/

Fisher, Jeffrey, Dean Gatzlaff, David Geltner, and Donald Haurin. "Controlling for the impact of variable liquidity in commercial real estate price indices." *Real Estate Economics* 31, no. 2 (2003): 269-303.

Giloth, Robert and John Betancur. 1988. "Where Downtown Meets Neighborhood: Industrial Displacement in Chicago, 1978-1987." *Journal of the American Planning Association* 54 (3): 279-290.

Hoelzel, Nathanael Z. and Nancey Green Leigh. 2013. *A New Normal After the Great Recession? Smart Growth Policies for Urban Industry*: Smart Growth Online.

Istrate, Emillia and Nicholas Marchio. 2012. *Export Nation 2012: How U.S. Metropolitan Areas are Driving National Growth*. Washington D.C.: Brookings Institute Metropolitan Policy Program.

Jacoby, Henry D., Francis M. O'Sullivan, and Sergey Paltsev. 2011.*The Influence of Shale Gas on US Energy and Environmental Policy*.

Jaquet, D. B. 2013. *A GIS Multicriteria Analysis for Siting a Sun/wind Powered Plastic Reprocessing Facility in the Contra Costa County, California Recycling Market Development Zone: a Thesis Presented to the Department of Humanities and Social Sciences in Candidacy for the Degree of Master of Science* (Doctoral dissertation, Northwest Missouri State University).

Jiang, Hong and J. Ronald Eastman. 2000. "Application of Fuzzy Measures in Multi-Criteria Evaluation in GIS." *International Journal of Geographical Information Science* 14 (2): 173-184.

Jun, Chulmin. 2000. "Design of an Intelligent Geographic Information System for Multi-Criteria Site Analysis." *Urisa-Washington Dc-* 12 (3): 5-18.

Kotval, Zenia and John R. Mullin. 1994. "The Coming Crisis in Industrial Land: A Planning Perspective." *Economic Development Quarterly* 8 (3): 302-308.

Lachapelle, U., Frank, L., Saelens, B. E., Sallis, J. F., & Conway, T. L. 2011. Commuting by public transit and physical activity: where you live, where you work, and how you get there. *Journal of physical activity & health*, *8*.

Lanza, Steven P. Winter 2013*. A Manufacturing Report Card: Does Connecticut make the Grade*. Storrs, Connecticut: The Connecticut Economy.

Leigh, Nancey Green and Nathanael Z. Hoelzel. 2012. "Smart Growth's Blind Side: Sustainable Cities Need Productive Urban Industrial Land." *Journal of the American Planning Association* 78 (1): 87-103.

Malczewski, Jacek. 1999. *GIS and Multicriteria Decision Analysis*. United States: John Wiley & Sons.

McCarthy, Linda. 2002. "The Brownfield Dual Land-use Policy Challenge: Reducing Barriers to Private Redevelopment while Connecting Reuse to Broader Community Goals." *Land use Policy* 19 (4): 287-296.

Morris, John. "U.S. Industrial Real Estate Outlook: Strong Performance Propels Industrial Sector into 2014." Area Development Online. Area Development Online, last modified 2014, accessed February, 19, 2014,http://www.areadevelopment.com/EconomicsGovernmentPolicy/Q1-2014/US-industrial-real-estate-outlook-Cushman-Wakefield-23828267.shtml.

Moskowitz, Harvey S. and Carl G. Lindbloom. 1993. *The New Illustrated Book of Development Definitions*. New Brunswick, New jersey: Center for Urban Policy Research.

Mullin, John R. and Zenia Kotval. 2000. "The Industrial Zoning Crisis." *Zoning News: American Planning Association*, 15.

———and Zenia Kotval. 2006. "The Office/Industrial Land Dilemma: A Study of the Blackstone River Corridor in Massachusetts." *Economic Development Journal* 5 (3): 16-22.

National Broadband Map. 2014. "National Broadband Map." accessed April 9, 2014, http://www.broadbandmap.gov/

National Wildlife Federation. "What is Biodiversity" Last modified 2014, accessed April 24, 2014, http://www.nwf.org/Wildlife/Wildlife-Conservation/Biodiversity.aspx

Ohri, Anurag, Prabhat Kumar Singh, and Priyanka Kumari Singh. "Spatial Multi Criteria Analysis for Siting Industries." .

Quinn, C., 2005. Warehouses big growth trend in exurbs. Atlanta Journal – Constitution (December 24), 3E.

Regional Plan Association. May 2013*. Transit Oriented Development Toolkit for Connecticut*.

Reisi, Marzieh, Lu Aye, and Alireza Soffianian. 2011. "Industrial Site Selection by GIS in Isfahan, Iran."IEEE, .

Randolph, J. 2004. *Environmental land use planning and management*. Island Press.

Russo, John and Sherry Lee Linkon "The Social Costs of Deindustrialization." Manufacturing a Better Future for America, ed. By Richard McCormack Youngstown State University 2008 Accessed, April 15, 2014, http://cwcs.ysu.edu/resources/CWCS-publications/social-costs-of-deindustrialization date accessed: 3/10/2012

Schueler, TR and HK Holland. 2000. "The Importance of Imperviousness in the Practice of Watershed Protection." *Center for Watershed Protection. Elliot City, Maryland* (1): 7.

Smith, David Marshall. 1981. *Industrial Location: An Economic Geographical Analysis* Wiley New York.

Squires, Gregory D. 2002. *Urban Sprawl and the Uneven Development of Metropolitan America*. Washington DC: Urban Institute Press.

State of Connecticut, Department of Labor. 2013 "Labor Market Information." Annual Averages-Employment & Wages by Industry (QCEW) - State of Connecticut, Last modified June 20, 2013, accessed April 5, 2014, http://www1.ctdol.state.ct.us/lmi/202/202_annualaverage.asp

———. 2013 "Labor Market Information." Annual Averages-Employment & Wages by Industry (QCEW) - State of Connecticut, Last modified March 26, 2013, accessed April 5, 2014, http://www1.ctdol.state.ct.us/lmi/projections.asp

Steiner, Frederick R and Kent Butler. 2007. *Planning and Urban Design Standards*. Hoboken, New Jersey: John Wiley and Sons.

Steiner, Frederick R., Kent Butler, and American Planning Association. 2012. *Planning and Urban Design Standards* John Wiley & Sons.

Strategic Economics. January 2012*. South Fremont / Warm Springs Area Impact Analyses: Fiscal and Economic Impacts of Proposed Land use Alternatives*. Fremont California: City of Fremont.

Transportation Research Board. 2007. *TCRP Report 95: Traveler Response to Transportation System Changes*. Washington DC: Federal Transit Administration.

United States Census Bureau. "Annual Estimates of the Resident Population for Incorporated Places Over 50,000, Ranked by July 1, 2012 Population: April 1, 2010 to July 1, 2012." Population Estimates. United States Census Bureau, last modified March 27, 2014, accessed February 1, 2014, http://www.census.gov/popest/data/index.html.

———. 2012 "North American Industry Classification System." 2012 NAICS. United States Census Bureau, accessed April 5, 2014, http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2012

United States Census Bureau, American Fact Finder. "American Community Survey." American Fact Finder. United States Census, accessed February, 5, 2014,http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

United States Conference of Mayors. 2010. *Recycling America's Land: A National Report on Brownfields Redevelopment*. Washington DC: United States Conference of Mayors.

———. "Redeveloping Brownfields." United States Conference of Mayors, http://www.usmayors.org/71stAnnualMeeting/brownfields_060903.asp.

United States Environmental Protection Agency. "Brownfields and Land Revitalization." Environmental Protection Agency, last modified October 4, 2011, accessed March 2, 2014,http://www.epa.gov/brownfields/overview/glossary.htm.

Urban Land Institute. Industrial and Office Park Development Council. 1975. *Business and Industrial Park Development Handbook*. Washington DC: Urban Land Institute.

Weber, Alfred. 1929. *Theory of the Location of Industries*. Translated by Carl J. Freidrich. Toronto, Canada: The University of Chicago Press.

Weitz, Jerry and Tom Crawford. 2012. "Where the Jobs are Going: Job Sprawl in US Metropolitan Regions, 2001–2006." *Journal of the American Planning Association* 78 (1): 53-69.